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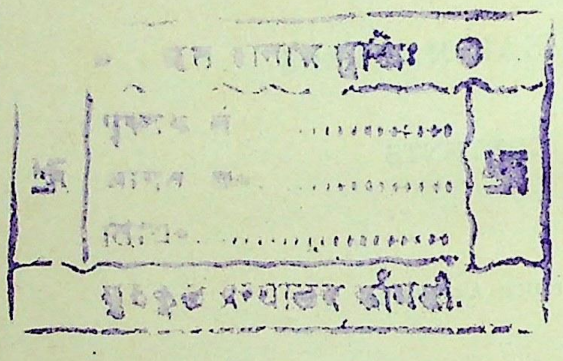
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The Local Reception Committee made all local arrangements necessary for the transaction of the scientific activities of the Session as well as for the accommodation of the members and delegates who attended the Session.

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Canada

Dr. J. T. Wilson—National Research Council

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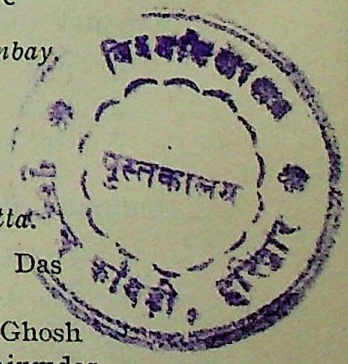
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7. Shri M. M. Singh
8. Dr. M. C. Tewari
9. Dr. J. S. P. Yadav

Indian Veterinary Research Institute, Izalnagar.

1. Dr. R. P. Chaudhuri
2. Dr. S. S. Khera
3. Dr. D. N. Mullick
4. Dr. S. S. Prabhu
5. Capt. S. B. V. Rao
6. Shri C. Seetharaman
7. Dr. G. L. Sharma
8. Dr. H. D. Srivastava

Regional Research Laboratory, Jammu & Kashmir.

1. Dr. I. C. Chopra
2. Dr. D. Ganguly
3. Dr. K. C. Gupta
4. Dr. L. D. Kapoor

Central Electrochemical Research Institute, Karaikudi.

1. Dr. K. S. G. Doss
2. Shri U. H. Narayanan
3. Shri S. K. Rangarajan
4. Dr. H. V. K. Udupa

Central Road Research Institute, New Delhi.

1. Shri S. Bagchee
2. Shri S. R. Bindra
3. Shri R. Krishnamachari
4. Shri R. M. Palit

Indian Agricultural Research Institute, New Delhi.

1. Dr. T. D. Biswas
2. Dr. S. M. Chatterjee
3. Dr. B. Choudhury
4. Dr. K. C. Gulati
5. Dr. E. S. Narayanan
6. Dr. A. T. Natarajan
7. Dr. B. P. Pal
8. Dr. R. Prasada
9. Dr. S. V. S. Shastry

Central Building Research Institute, Roorkee.

1. Shri S. K. Chopra
2. Shri N. K. D. Choudhury
3. Shri G. W. Kapse
4. Dr. V. S. Ramachandran

GOVERNMENT OF INDIA AND STATE GOVERNMENTS

Oil & Natural Gas Commission, Dehra Dun.

1. Shri G. Kohli
2. Dr. Hari Narain
3. Shri L. P. Mathur
4. Shri M. C. Poddar

India Meteorological Department, Government of India, New Delhi.

1. Dr. M. K. Vainu Bappu
2. Shri P. Jagannathan
3. Dr. P. R. Pisharoty
4. Shri S. Rangarajan
5. Dr. S. N. Sen
6. Shri H. N. Srivastava
7. Shri A. Yacob

Planning Commission, New Delhi.

1. Dr. K. P. Basu

Research & Development Organisation, Ministry of Defence, New Delhi.

1. Dr. H. K. Acharya
2. Shri B. B. Chaudhuri
3. Shri J. C. Chaudhuri
4. Dr. A. N. Deb
5. Dr. A. N. Deb
6. Dr. A. N. Dey
7. Shri R. Hridaynath
8. Dr. D. D. Khanolkar
9. Shri S. S. Rajput
10. Shri S. Ramabhadran
11. Dr. V. R. K. Rao
12. Shri P. C. Rath
13. Dr. B. N. Singh
14. Shri Narendra Singh
15. Dr. A. K. Tyagi
16. Shri L. K. Wadhwa

Education 'F' Department, Government of Kerala, Trivandrum.

1. Shri S. Gopala Menon

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PROGRAMME OF THE SESSION

The 49th Annual Session of the Indian Science Congress Association was held in Cuttack from the 3rd to the 9th January, 1962, under the auspices of the Utkal University. The Session was inaugurated at 4 P.M. on Wednesday the 3rd January, 1962, in a specially erected pandal in the Campus of the oldest educational institution of Cuttack, viz., Ravenshaw College. About 5,000 visitors including more or less 2,000 delegates from different parts of the country attended the inaugural function. Delegates from almost all the important national scientific societies abroad and a few individual foreign scientists numbering in all about 50 were present.

The inaugural function started with the singing of the National Anthem, "Jana Gana Mana....." and an invocation when Prof. P. Parija, Vice-Chancellor, Utkal University and Chairman, Reception Committee welcomed the visiting scientists from abroad, delegates and others in a short and attractive speech.

Shri Y. N. Sukthankar, Chancellor of the Utkal University, then delivered his brief opening address according a warm welcome to all.

The Prime Minister of India, Shri Jawaharlal Nehru, delivered his inaugural address urging the scientists to put science to the service of mankind.

The President, Dr. B. Mukerji, then delivered his thought-provoking Presidential Address on "Impact of Life Sciences on Man".

After the delivery of the Presidential Address, the Foreign Secretary of the Association, Prof. M. S. Thacker, introduced the guests from abroad to the Prime Minister of India, Shri Jawaharlal Nehru, and other members, visitors and scientists present on the occasion.

Before the vote of thanks was tendered, the exhibition of scientific apparatus and instruments which was organised as a part of the Science Congress, was declared open by the Chief Minister of Orissa, Shri Bijoyananda Patnaik.

Dr. B. Samantarai, one of the Local Secretaries, expressed a hearty vote of thanks to the Prime Minister of India, and others present at the function, while Prof. B. C. Guha, General Secretary (Headquarters), conveyed, on behalf of the Association, their sincere thanks to all, specially the local organisers, stressing the utility of the wide opportunities of social contacts at personal level presented by the Science Congress.

The ceremony then terminated with the singing of the song "Bharat Geetika".

SECTIONAL PRESIDENTIAL ADDRESSES

The Presidential Addresses of the Sections were delivered as follows : Thursday, 4th January, 1962 : 9-45 A.M. Physics, Botany, Physiology, Psychology & Educational Sciences, Engineering & Metallurgy; 10-45 A.M. Statistics, Chemistry, Geology &

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Geography, Zoology & Entomology; 11-45 A.M. Mathematics, Agricultural Sciences, Medical & Veterinary Sciences, Anthropolgy & Archaeology.

MEETINGS OF THE COMMITTEES

Inauguration of the Indian Science Congress on Wednesday, January 3rd, 1962, at 4 P.M.; General Committee of the I.S.C.A. met on Sunday, January 7th, 1962, at 3-30 P.M.

Meetings of the Sectional Committees on Thursday, January 4th at 9 A.M.; Friday, January 5th at 9 A.M.; Saturday, January 6th at 9 A.M.; Sunday, January 7th at 9 A.M.; Monday, January 8th at 9 A.M.; Tuesday, January 9th at 9 A.M.

The Council met on Tuesday, January 2nd at 4-45 P.M.; Executive Committee on Tuesday, January 2nd at 3-15 P.M. and on Sunday, January, 7th at 11 A.M.; Committee on Science & its Social Relations met on Thursday, January 4th at 2-30 P.M.

SOCIAL FUNCTIONS

January 4th :	At Home Entertainment
January 5th :	At Home Entertainment
January 6th :	At Home Entertainment
January 7th :	At Home Entertainment

POPULAR LECTURES

Thursday, 4th January, 1962, at 6 P.M. on "Chemical Approach to Mental Disorders" by Dr. Ernest Jucker; at 6-45 P.M. on "The Moral Value of Scientific Pursuit" by Dr. N. R. Dhar.

Friday, 5th January, 1962, at 6 P.M. on "Atom, Steel and Man" by Dr. G. P. Chatterjee; at 6-45 P.M. on "Life and Work at High Pressures" by Prof. W. D. M. Paton.

Saturday, 6th January, 1962, at 6 P.M. on "The World of the IGY" by Dr. J. T. Wilson; at 6-45 P.M. on "Tobacco and Cancer Prevention" by Dr. H. Druckrey.

Sunday, 7th January, 1962, at 6 P.M. on "Recollections and Serendipities" by Dame Kathleen Lonsdale; at 6-45 P.M. on "Rock Magnetism and Continental Drift" by Prof. P. M. S. Blackett.

Monday, 8th January, 1962, at 6 P.M. on "Freedom and Responsibility of Science" by Prof. R. Havemann.

SPECIAL LECTURES

Mathematics : "Congruence Geometry" by Prof. C. N. Srinivasienger and "Covering Problems in the Geometry of Numbers" by Prof. R. P. Bambah.

Physics : "Spectroscopy of nuclear gamma rays and X-rays by direct crystal diffraction methods" by Jesse W. M. DuMond and "Thermal Vibrations in Crystals" by Dame Kathleen Lonsdale.

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Chemistry : "Photochemical Reaction and Complexes" by Prof. R. Havemann and "Inconvenience of Utilising Radio-Isotopes in Studying the Complex Combinations" by Mrs. Raluca Ripan.

Geology & Geography : "New Evidence of Major Movements in the Crust and Mantle" by Dr. J. T. Wilson.

Botany : "Carrots & Cocoanuts : Some investigations on growth" by Prof. F. C. Stewart and "The hormonal control of the growth of roots" by Prof. H. E. Street.

Medical & Veterinary Sciences : "Muscle Tonus" by Prof. G. Haeggqvist, "Pharmacological bases of cancer chemotherapy" by Dr. H. Druckrey and "The Current Status of Hytatid Disease" by Dr. E. L. Schiller.

Prof. N. Salageanu delivered a special lecture on "Personal researches in photo synthesis" at a joint Session of the Sections of Chemistry and Botany.

Prof. R. Truhaut delivered a special lecture on "Evaluation of Toxicology and Cancerology in food mixtures; First results obtained in examining naturally coloured material produced in India" at a joint Session of the Sections of Medical & Veterinary Sciences and Physiology.

Dr. H. Druckrey delivered a special lecture on "Chemical constitution of carcinogenicity of nitrosamines" at a joint Session of the Sections of Physiology and Chemistry.

SYMPOSIA AND JOINT DISCUSSIONS WERE HELD AS FOLLOWS :

Thursday, 4th January, 1962

Subject	Section
1. Absolute Summability of Fourier Series ...	Mathematics
2. Control of errors in sample surveys	Statistics
3. Physicochemical methods in the determination of structure of molecules	Chemistry
4. Statistical Methods in Geosciences	Geology & Geography
5. Evolutionary trends in Gymnosperms ...	Botany
6. Hepatic Cirrhosis	Medical & Veterinary Sciences
7. Maximisation of Agricultural Production ...	Agricultural Sciences

Friday, 5th January, 1962

1. Precipitation reactions	Chemistry
2. Role of Maps in Geological and Geographical Work	Geology & Geography
3. Parasitism and Symbiosis	Botany
4. Role of Parasitology in Planning	Zoology & Entomology
5. Industrialisation and its Impact on tribal life ...	Anthropology & Archaeology
6. Newer oral diuretics, their actions and uses ...	Medical & Veterinary Sciences
7. Water requirements of Crops	Agricultural Sciences
8. Interrelationship between vitamins and hormones	Physiology
9. Nature of personality	Psychology & Educational Sciences
10. High temperature properties and techniques ...	Engineering & Metallurgy
11. Numerical analysis and modern computing devices	Statistics (jointly with the Sections of Mathematics and Engineering & Metallurgy)

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Saturday, 6th January, 1962

Subject	Section
1. Radio and Microwave Spectroscopy	Physics
2. Role of Phosphate in Biochemical reactions ...	Chemistry
3. The Siwalik System	Geology & Geography
4. Cytogenetics of Polyploids	Botany
5. Reproductive Physiology of Vertebrates ...	Zoology & Entomology
6. Study of Motivation	Psychology & Educational Sciences
7. Testing of Electrical Equipment (a) High Voltage, (b) Short Circuit	Engineering & Metallurgy
8. Reclamation of Waste Lands	Agricultural Sciences
9. Statistical Methods in Medical Sciences ...	Statistics (jointly with the Section of Medical & Veterinary Sciences)

Sunday, 7th January, 1962

1. Co-ordination Complexes	Chemistry
2. Palaeomagnetic studies in relation to wandering of the Continents	Geology & Geography
3. Problem of student unrest	Psychology & Educational Sciences
4. Fuel Energy Problems in India	Engineering & Metallurgy
5. Growth and Nutrition	Anthropology & Archaeology (jointly with the Sections of Medical & Veterinary Sciences and Physiology)
6. Utilisation of Agricultural Waste	Agricultural Sciences (jointly with the Section of Chemistry)

Monday, 8th January, 1962

1. Anthraquinone Pigments	Chemistry
2. Haemolytic Anaemia	Medical & Veterinary Sciences

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OPENING PROCEEDINGS

Welcome Address by Prof. P. Parija, Vice-Chancellor, Utkal University.

On behalf of the Reception Committe and on behalf of the University, I have the honour to extend a very hearty welcome to you all, to this University. Though comparatively young, this University bears the name of a land whose history goes back to the epic days of the Mahabharat. This land has stood for peace and amity throughout the ages. History tells us that invaders like Ashoka came here to conquer but were culturally conquered to the cult of peace and non-violence. From here cultural missions went by land and sea to far off countries to spread religion and carry the messages of friendship. Here existed Budhist Univerities which were visited by travellers like Huen Tsang. Religious leaders like Shankara, Ramanuja, Chaitanya and Guru Nanak came here and established centres to spread their tenets. The cult of Jagannath at Puri preached equality of all men. Even in our time the integration of princely States began here.

During the long periods of peace, art, literature, architecture and the basic principles of science and technology were developed to an admirable level. Remnants of these are still existing to exact admiration from those who see them. Even during the vicissitudes of fortune of this land, the people clung to their faith in amity and peaceful existence.

Into this cultural set-up our University came into existence less than two decades ago. It is striving its utmost to provide instructions in all fields of knowledge so that its alumni may have an opportunity to synthesise a culture composed of all the good elements from the traditional culture of our land and from the modern scientific age.

We ventured to invite the Indian Science Congress Association to hold its Fortyninth Session under the auspices of this University because this association brings together students of Science not only from all the States of India but is also attended by delegates from countries outside India. Such a cosmopolitan gathering fits well into the tradition of this land.

Apart from this aspect, a congregation like the Indian Science Congress is attended by men and women who have established position in their respective fields and also by younger generations who are striving to carve a position for themselves in the scientific world. Such a get-together is of mutual benefit. Men with established positions serve as guiding stars to the young aspirants while the elder men have the satisfaction after observing the keenness evinced by the youthful members that the search for truth will be continued along the paths shown by them.

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We are conscious of our limitations so far as material comforts are concerned but we hope that the delegates will forgive us any defects and deficiencies which are not due to any lack of heartiness in our welcome.

I would now request the Governor, our Chancellor and Patron-in-Chief, to deliver his opening speech.

Address by Shri Y. N. Sukthankar, Governor of Orissa, and Chancellor, Utkal University.

This is a great day for Orissa and unitedly we feel proud, and happy and encouraged that it should have been decided to hold the Indian Science Congress here and we are meeting accordingly here this afternoon. Science has made great progress in the last two or three centuries. The progress that it has made has brought a complete change in the outlook of men and probably has made us little more rational, providing us with scientific outlook. Besides its administering wants and desires, it administers our comforts and conveniences, and yet during the last ten or twenty years or may be fifty years there have been developments which have disturbed the mankind. Engines of destruction have been perfected which may annihilate in short time the whole of the mankind. These are the contradictions and failures of the science. But if we turn to other spheres, say philosophy or religion, we perhaps find similar contradictions and difficulties are there. Philosophy and religion have certainly contributed more to human thought and perhaps there have been outstanding products of human thought in those fields. Yet it cannot be denied that there were times when some people adroit or addict were led to inaction. In some other cases perhaps they were pushed into various warring and surgical groups. So these contradictions and failures in these various fields disturbed all thinkers of mankind. You Mr. Prime Minister an idealist and realist at the same time. Those of us who had great privilege of working close to you, have often felt that you have evolved some synthesis out of the jargon, some harmony which sustains your faith in peace and goodwill all over the world. We have considered it extremely fortunate that in spite of multifarious demands you should have found time to be present here in our midst to-day. May be your illuminating and wise remarks may light some dark patches in our disturbed mind. With these words Mr. Prime Minister, we have great pleasure in requesting you to inaugurate the 49th Indian Science Congress.

Inaugural Address by Shri Jawaharlal Nehru, Prime Minister of India, at the 49th Session of the Indian Science Congress at Cuttack.

I am here to attend this Annual Session of the Science Congress again. Last year I could not be present although in the previuos years I had made it almost a regular practice to come to these Annual Sessions. I come here for a variety of reasons. I would, of course, have liked to stay on some time and try to imbibe some wisdom. But as I cannot do

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that, I do not wish to come in the way of learned people discussing learned subjects which perhaps I might not be able to understand. So I come here really to convey my own and our Government's greetings to you, scientists of India, and our foreign guests, and to tell you what great importance we attach to the growth of science here in India. It is growing of course and growing fast, and yet we have much leeway to make up.

To-day almost everyone almost everywhere in the world pay obeisance to science. The world we live in is one moulded very much by science, and it is its offspring. So the mere idea of encouraging science as such by paying obeisance to it, is necessary no doubt, but still not so necessary because it is the accepted tenet to-day that we have to worship at the temple of science. That is so, and it becomes more so, because the space of scientific development becomes faster and faster. As you all know, we are now apparently on the verge of some kind of space age and human beings have gone into space—some distance anyway. There can be no doubt that this is a tremendous achievement and may be followed by still greater triumphs in other directions. Now there is no doubt about the advance of science. But doubts arise in my mind—and in the minds of many people about the use that science might be put to, for the benefit of humanity. Science has to be pursued anyhow. We cannot escape it: it surrounds us; it presses and oppresses us. Science ultimaetly is a search for truth but sometimes that search leads us to an uncomfortable conclusion; because one has to search for truth and search for it without fear and as objectively as possible.

In India to-day, there are, I believe, considerable numbers of young men, and I am glad to say young women, who are doing scientific work of high quality. I particularly welcome these young women. Sometimes I have heard, and I say so with respect, that these young men and women are not given their fullest chance by the senior men roundabout them. This, if so, is unfortunate. Because it should be the pride and privilege of senior men to train and give every chance to the juniors working with them. Because really there is—I have no doubt—in India the material—the human material—peculiarly suited to scientific research and scientific progress. And now if that is what is happening, it would be a great pity if they are not given a good chance everywhere to go ahead. I do not know how far it is true; but I am told that many of the major discoveries of science were made by people who were comparatively young. They did good work afterwards too. But they started it at a fairly early age. It is, therefore, most important that we should encourage our young scientists and give them every facility to do research or any other work in the scientific field that they may be preferring to do. There is this aspect of research work.

Then there is another aspect which is particularly important in India to-day, that is the application of what you find out, for the benefit of our nation's work. That is very important, but it often happens in India

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that even when fine research work is done in the practical, or theoretical, field, it remains only in the laboratory. That is not very good.

There is also another matter which weighs down in my mind, about which I wish to say something. Science, as I said, is ultimately a search for truth, and further application of that truth as far as possible for the benefit of humanity. Well that has not always happened and it is not happening to-day. And the result is that we have to face tremendous problems in the world which create a sense of great instability and insecurity in the minds of men and uncertainty about the future. Now science is quite uninterested in this aspect and functions by itself—regardless of what might happen to the world or humanity. That is an important question, because too much interest may lead to science becoming less objective. That, too, is not good because we have before us all sorts of problems and conflicts arising in men's mind and in society and it is for science to deal with these matters. Ultimately, I suppose, it is really a question not directly of scientific research and the like, but some kind of change taking place in human thinking and the urges which the human beings have. Right from the earliest times, wherever you went, whether in Greece or in ancient India, one thing that was uppermost was 'Know Thyself'—whatever it meant. Evidently, that meant some kind of control over one's self. More and more we are controlling Nature and its ways and utilising them, but apparently less and less we control ourselves. Those who use those forces of Nature thus create a curious situation. Just when we have the power and the ways and means at our disposal for mastering those forces of Nature, of removing the causes of hunger and poverty, just then something else comes up and diverts our energy and mind in other directions—dangerous directions—which may lead even to doubts if man will survive at all and will not destroy himself. That is a very serious situation for every individual who thinks about it, and I have no doubt that scientists think about other matters apart from the subject to which they devote themselves.

Nearly all of us here, those who are Indians, know the name of the person I am going to mention. May be some of our foreign guests may have also heard about him, although he is not particularly known in foreign countries. India has a habit of producing odd men. One of the oddest men India has produced was Mahatma Gandhi. I rather doubt if that kind of persons would appear on the scene in other countries. So to-day we have another odd man, more or less in the same tradition. He is known as Acharya Binobha Bhave. Now I am mentioning his name for a particular purpose ; he is a man who, in this age of jet travel is going about from place to place without using any of the new methods of communication. He has in the course of last 13 years walked all over India not even taking an automobile so far as I know, nor any kind of conveyance or railway. He has walked all over this enormous country—which is a very odd thing to do in this age of science and swift travel. He has walked from village to village day after day. He is not young by any means,

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But some kind of strength keeps him going and he has visited almost every place in India—and visited a vast number of villages, sat down and talked to about half million of villagers, during the last 13 years. I think he has walked thirty thousand miles, or may be forty thousand, by road. Essentially he is a man whom one would call a religious type of man devoted to certain values, certain standards of behaviour—which normally would be called a religious approach. Yet he is going about saying something which rather takes us aback. He has been saying that Politics and Religion are out of date and they should be replaced by science and spirituality. It is a striking thing to say. He is not a scientist ; he is a great scholar, he knows many languages. But to say that religion should give place to science shows the value he attaches to science and replacing religion by what he calls spirituality.

Obviously, when he says that religion is out of place he means the form of religion. He brings in some kind of control through spirituality which is by no means opposed to religion but is rather in conformity with it. In other words he wants society to give science its due place and he wants some element of directions to it, with clogs on it to prevent it from going astray so as to maintain some standards of humam behaviour and thinking, and that he profits what he calls by spirituality. Now I am not trying to explain what he meant. Perhaps he may mean something else. But because when for the first time I heard him say that the world is a world of science, it impressed itself on my mind. Whether the world survives or dies, it would be by science. Yet undoubtedly we have to face tremendous problems. If we are not guided by some kind of standards and values which come not purely by science, but in some other way, then we may as well miss a tremendous opportunity. I may mention here to the scientists present that more and more I am told that science by itself, without some kind of ethical or moral approach, may lead us to disaster, how that is to be done is more than I can tell you. I am merely putting these problems before you so that you might give a little thought to them. I myself do not know how this can be brought about in a world where many people have ceased to be religious. To many religion is pure superstition which of course is entirely opposed to the spirit of science. For many it is ritual which again is more or less opposed to the scientific approach. For many religion is a standard of behaviour. Many of them feel that the way they worship, is something very special from other peoples' religions, and this points to a wrong path, whatever it is.

Now here in India and especially in this Province of Orissa, which in old days was called Kalinga, my mind travels to a famous period in Indian history, to a very famous man, who was the Emperor of those days—Asoka. Because it was in Kalinga where his peoples' army waged a war and it was here that he underwent some kind of transformation. In the middle of victory he renounced war. It was rather a remarkable thing for any country on way to triumph. But he renounced war and said

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henceforth he would have no war and he would only propagate righteousness whatever his views of righteousness were. He wrote many edicts, and got them inscribed in stone, rocks all over India and on pillars. You will find them in the greater part of India, and even in Afghanistan which was then included in India, and in Central Asia. They are very fascinating, these edicts in which he described his own change of mind, why he renounced war in the middle of victory. One particular edict represents, I think a basic approach, the basic Indian approach, to the question of religion. That is the approach of toleration. He said in his edict—and he has addressed, through his edicts, his own people, his own subjcets, spread throughout India. He ruled practically over the whole of India except a smal strip of South India and a great part of Central Asia. He said, addressing his subjects: "You must honour and observe your religion". The word religion is not quite correct—the word he used is 'Dharma' which has a wider meaning. But even as you honour your religion, you should honour and respect the views of others' religion, and the views of others who differ from you. If you honour their religion, they will honour yours. Now that is essentially a message of toleration not only in regard to religion but in the matter of one's views too. Now-a-days the conflict is more in the other fields than the field of religion. So Asoka 2300 or 2200 years ago inscribed this message which stares you to-day on the pillars all over India. The message is essentially a message of tolerance, and in a sense all this comes out of his wars in this part of India, which he gave up later. It comes to my mind, and I think it is something worth remembering, for us in India of course and even more for others.

Now this country, India, has had a long story, a long history. During these two thousand years it has seen many ups and downs. Now we are again here at a new stage of our existence, when having attained freedom, we seek to use that freedom for the betterment of our own people and in so far as it is possible, for service to the world and to world peace. It is an exciting thing to live in India to-day, and to see this changing sea, because it is changing and changing fairly rapidly. One sees, when one goes about, by measuring this change by looking at statistics and figures. That, I suppose, is necessary. But one sees much more, not only in figures, but in the faces of human beings all over India, the change that is coming over their faces and their ways of living and many other things. Perhaps one of the most striking things, is the vast number of boys and girls who go to schools and colleges to-day which are growing and jumping up every year. Our schools may not be very perfect and they are often criticised. Our colleges are also often criticised. They are gradually improving no doubt. But the fact remains that nearly 50 million boys and girls are now in our schools and colleges in India. It is a large number and it is increasing every year. Our own aim is that by the end of the Third Five-Year Plan this figure will go up to 67 millions. This will mean that every boy and girl of a certain age-group, will be going

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to school. That itself is a revolutionary factor ; this that is coming out of one's old rut of mind, thought and habit. But these are things that are happening and one sees them when one goes out.

India has been a poor country, at any rate, in the near past. From any statistical point of view, we are at the bottom of the scale of poverty, and yet India has retained, in spite of her poverty, some virtues too. It is surprising to see how people of India, the people of our villages, in spite of their poverty, can sing and dance and laugh. It is a great virtue to see them sing and dance and laugh, in the face of burdens that life puts upon them. But what I was saying, was that I have been seeing them in crowds, all over India and I am seeing them for the last fifty years, and it has been an exhilarating experience to see these changes—to see that they are better fed and better clothed. They live in better houses to some extent, and better houses are growing up. Their agriculture is improving. Small industries are growing up in villages, in rural areas, apart from the big industries about which so much is said in newspapers. But the most important change one notices has occurred in the attitude of our village folk—and I think more of our village folk, when I think of India, than our city folk, because the city folk can, more or less, look after themselves. I see the process of a measure of self-assurance coming to our village people, I see the self-reliance coming to them too. They do not go about begging from Ministers or officials, but realise that they have to do the job themselves. It is only when that realisation comes to them that they do their jobs themselves and progress. No Government can push them to any large extent, nor can any official do the job for them.

Here in India one of the most revolutionary changes has been, what is called Panchayati Raj. There is devolution of authority, decentralisation of authority to a large extent, of our administrative apparatus, in giving power to those village councils. It has gone very far and it is producing a wonderful effect upon them, having themselves the power and not to look up to the officials. So all these changes demonstrate a great change coming over India, and this is heartening, because perhaps in the final analysis, the biggest thing we have to do is to pull out our people, a great majority of them—out of this tremendous rut of life which they have fallen into, the static condition, the unchanging condition, in which they have lived, as for instance, ploughing in the same way as they ploughed two thousand years ago—may be three thousand years ago—carrying on the same thing. That is the worst thing that had happened to India. They got stuck in rut in thinking. We need to pull them out of that rut—to give them some wider vision, and in effect to make them realise that there is something like science in the world which changes things. I find that this is difficult and it is a pretty difficult matter to pull out hundreds of millions of people out of their rut. But it is not so difficult as I thought it first. But these people really are not influenced so much by wordy argument. They are influenced by something, which

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they can see and feel, and which convinces them. But once they see the change, they go on.

I am sorry I have been talking about matters which may not strictly be pertinent to the Science Congress. But they are pertinent in my mind, because, I want the influence of science, to some extent, the temper of science, to spread out all over India. And I think that is going to happen and is happening to-day, because large numbers of our young men are studying scientific and technological subjects too. The men in the factory and in the field and elsewhere are beginning to be affected, may be to a slight extent. But even this slightest extent, for hundreds of millions makes a vast difference in the end.

So science is obviously for the world and if I may say, for us in India too. It is only through science that we can hope to solve our basic problems. After the basic problems are solved, there are other problems which are affecting the rest of the world to-day, but they come really after the primary necessities of human beings are fulfilled. And it is only thereafter that we can get entangled to some extent in more difficult problems. But we must to a certain extent get entangled because we cannot isolate from the rest of the world. But we cannot at the same time escape our basic problems.

But one problem still remains that I mentioned to you a little while ago and that is the problem of humanity to-day, which really has been aggravated by the advance of science, that is, by the power which science has given to the humanity. Science apparently gives all power in the world, but it has not yet succeeded in giving wisdom to human being. Power has gone far beyond the quantum of wisdom that human beings have. There lies the tremendous danger that power may be misused for any improper purpose. History has throughout recorded the misuse of power. But the difference lies in that the misuse of power in old days did harm,—infinite harm anyway, but now the harm would be much more intense and in the ultimate effect may threaten the survival of man. Therefore, this element of wisdom comes in. And perhaps we might learn not only through science to-day, but from the words of wisdom that have been said in many countries in the past by great men who have influenced the conditions of humanity.

I am sorry if I have gone rather astray from the normal subjects you have to consider. But I have these matters in mind and I put them before you. Perhaps as was stated in the previous speeches, it is a habit. I hope Mr. Vice-Chancellor it is a habit to praise one's country and the great men who have lived in it. It is a sort of habit, no doubt, which one is apt to exaggerate too. But here it is a hard fact. Orissa, the State where you are meeting, is one of the poorest at present in India—economically one of the most backward. It has great resources and it is pulling up. But it is a fact that it is economically a backward State of India. Recently they have a Steel Plant built up, they have got river valley schemes, and other things are happening. But one thing comes to my

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mind always when I come here, that nearly 2000 or 1800 years back it is the people of Orissa, on the east coast of India that ventured out in our little boats, carrying messages from India, carrying our culture, our architecture, and so many things across the seas all over South-east Asia, and have left their influence on the people—a vast community of people in those countries of South-east Asia, every one of them. If you visit them to-day, there is this impress of Indian culture. Even the language, that is, the Sanskrit language has affected their language. Their architecture has been also powerfully affected. You will find the finest examples of Indian architecture outside India, in South-east Asia and there are so many other things. It is interesting to see that these people started this great movement from India. It was not a military movement. It was not conquest. But our people left an impression which has lasted till to-day. For hundreds of years it was a very powerful one. So it is interesting that these people—these enterprising adventure—adventurous people—ventured out from the east coast of Kalinga and built up their communities there. Evidently they must have had tremendous vitality in those days which the Indian people have lost due to a variety of causes, which divide them to a bit due to religion, customs, and superstitions. I believe they are in the process of getting back their vitality and I want science to help them in that process.

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MEETINGS OF THE COMMITTEE

PROCEEDINGS OF THE MEETING OF THE GENERAL COMMITTEE

The Annual Meetings of the General Committee of the Indian Science Congress Association was held at 3-30 P.M. on Sunday the 7th January, 1962, in Ravenshaw College, Cuttack.

The following Members were present :—

1. Dr. B. Mukerji—President in the Chair
2. Dr. N. R. Dhar—Past President
3. Dr. B. C. Acharya
4. Dr. H. K. Acharya
5. Shri N. Acharya
6. Shri P. G. Adyalkar
7. Dr. A. K. Banerjee
8. Shri P. K. Banerjee
9. Dr. S. Banerjee
10. Shri T. D. Bansal
11. Shri A. P. Battacharya
12. Dr. P. K. Bose
13. Dr. V. Cadambe
14. Shri P. K. Chatterjee
15. Shri J. C. Chaudhuri
16. Shri K. L. Chaudhuri
17. Dr. B. Chaudhury
18. Prof. A. B. Das
19. Shri P. K. Das ...
20. Dr. D. S. Datar
21. Dr. A. K. Dey
22. Shri Arun K. Dey
23. Shri Samir K. Dey
24. Dr. V. S. Dubey
25. Dr. G. C. Esh
26. Shri R. K. Gupta
27. Dr. M. M. Hasan
28. Dr. A. K. Harza
29. Dr. A. G. Jhingran
30. Shri T. Kabi
31. Shri M. S. Kanungo
32. Dr. K. K. Majumdar
33. Shri K. L. Malhotra
34. Dr. R. C. Misra
35. Dr. R. P. Mitra
36. Shri R. G. Mukherji
37. Shri Kailash Nath Munshi
38. Prof. B. Nayak
39. Prof. P. Parija
40. Shri Ranada Sundar Paul
41. Prof. B. N. Prasad
42. Shri M. S. Prasad
43. Shri S. N. Puri
44. Shri B. N. Raina
45. Dr. D. V. Ramana Rao
46. Dr. S. P. Raychaudhuri
47. Dr. K. P. Rode
48. Dr.(Miss) K. K. Rohatgi
49. Prof. S. K. Roy
50. Shri S. N. Rudra
51. Dr. Shivdayal Saksena
52. Father H. Santapau
53. Dr. J. C. Sen Gupta
54. Dr. P. N. Sen Gupta
55. Dr. T. R. Shroff
56. Dr. E. J. Singh
57. Dr. R. N. Singh
58. Dr. S. K. Sircar
59. Shri S. N. Sinha
60. Shri Surendra Nath Sinha
61. Dr. S. R. Sinha
62. Shri A. M. Talati
63. Mrs. Aparna Tapadar
64. Dr. D. C. Tapadar
65. Shri J. S. P. Yadav
66. Dr. R. N. Rath } Local
67. Dr. B. Samantarai } Secretaries
68. Dr. P. K. Bose—Treasurer
69. Prof. B. C. Guha—General Secretary

Before the commencement of business, the President, Dr. B. Mukerji, referred in touching terms to the sad and sudden demise of one of the young delegates attending the Science Congress, Mrs. Shraddha Banerjee, a student of the 6th Year Class in Geography of the Banaras Hindu University, who came to Cuttack with her Professor, Dr. R. L. Singh, along with a batch of students and died of heart failure on the 6th January morning. The Members stood in silence for a minute

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paying homage to the memory of the departed soul, and it was resolved that condolences and sympathies be sent to her husband ond other members of the bereaved family.

Item 1—To confirm the minutes of the meeting of the General Committee of the Indian Science Congress Association held on the 7th January, 1961.

The General Secretary, Prof. B. C. Guha, informed the Committee that the minutes of the last meeting of the General Committee were printed in Part I of the Proceedings of the last Session and copies thereof were sent to all Members as usual. Besides, separate printed copies were distributed at the meeting.

Confirmed.

Item 2—To announce the name of the General President for the Session to be held in January, 1964.

The General President, Dr. B. Mukerji, announced that Prof. B. C. Guha, Professor and Head of the Department of Applied Chemistry, University College of Science & Technology, Calcutta, was duly elected as the General President for the Session to be held in January, 1964.

Item 3—To announce the results of election of ten Members to the Executive Committee and seven Members to the Council for 1962-63.

The President, Dr. B. Mukerji, announced the names of the following ten members elected to the Executive Committee and seven members elected to the Conncil, as shown, for the year 1962-63 :—

Executive Committee

1. Dr. H. J. Bhabha (Bombay)
2. Dr. N. R. Dhar (Allahabad)
3. Dr. D. M. Bose (Calcutta)
4. Prof. P. Parija (Cuttack)
5. Dr. (Mrs.) Asima Chatterjee (Calcutta)
6. Dr. A. L. Mudaliar (Madras)
7. Prof. T. R. Seshadri (New Delhi)
8. Dr. R. S. Krishnan (Bangalore)
9. Dr. V. R. Khanolkar (Bombay)
10. Dr. Triguna Sen (Calcutta)

Council

1. Dr. P. N. Bhaduri (Calcutta)
2. Dr. T. N. Ghosh (Calcutta)
3. Prof. T. S. Sadasivan (Madras)
4. Shri A. K. Roy (Calcutta)
5. Dr. B. K. Kar (Calcutta)
6. Prof. Kalyan Bagchi (Calcutta)
7. Shri S. Basu (Calcutta)

Item 4—To announce the names of the Sectional Presidents for the Session to be held in January 1963.

The President, Dr. B. Mukerji, read out the following names of members elected as Presidents of the thirteen sections as shown against their names :—

Mathematics	Prof. C. T. Rajagopal (Madras)
Statistics	Dr. P. V. Krishna Iyer (Delhi)
Physics	Dr. R. Ramanna (Bombay)
Chemistry	Dr. K. S. G. Doss (Karaikudi)
Geology & Geography	Prof. P. R. J. Naidu (Madras)
Botany	Prof. S. M. Sircar (Calcutta)
Zoology & Entomology	Dr. B. S. Chauhan (Calcutta)
Anthropology & Archaeology ...	Prof. K. M. Kapadia (Bombay)
Medical & Veterinary Sciences ...	Dr. Srish Chandra Seal (New Delhi)
Agricultural Sciences	Dr. S. C. Sen (Kanpur)
Physiology	Dr. D. P. Sadhu (Izatnagar)
Psychology & Educational Sciences	Dr. P. N. Prabhu (Ahmedabad)
Engineering & Metallurgy ...	Shri R. G. Mukherji (Calcutta)

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Item 5—To announce the names of Members elected to different Sectional Committees for the Session to be held in January 1963.

The President, Dr. B. Mukerji, read out the following names of four Members elected as Members of each Sectional Committee in respect of the thirteen Sections as shown :—

Mathematics	1. Prof. R. P. Bambah (Chandigarh) 2. Prof. J. A. Siddiqi (Aligarh) 3. Dr. (Miss) Pramila Srivastava (Varanasi) 4. Dr. R. Mohanty (Cuttack)
Statistics	1. Shri A. P. Bhattacharay (Roorkee) 2. Dr. M. N. Das (New Delhi) 3. Dr. D. N. Lal (Patna) 4. Dr. C. Mishra (Cuttack)
Physics	1. Dr. A. K. Saha (Calcutta) 2. Dr. B. N. Singh (New Delhi) 3. Dr. B. D. Nagchaudhury (Calcutta) 4. Shri N. L. Singh (Varanasi)
Chemistry	1. Dr. Jagdish Shankar (Bombay) 2. Dr. D. K. Banerjee (Bangalore) 3. Dr. S. P. Mushran (Allahabad) 4. Dr. (Miss) K. K. Rohatgi (Jadavpur)
Geology & Geography	1. Shri P. G. Adyalkar (Calcutta) 2. Shri P. V. Dehadrai (Dehra Dun) 3. Prof. M. S. Honrao (Dharwar) 3. Prof. K. G. Bagchi (Calcutta)
Botany	1. Prof. B. Samantarai (Cuttack) 2. Father H. Santapau (Calcutta) 3. Dr. B. M. Johri (Delhi) 4. Prof. R. P. Roy (Patna)
Zology & Entomology	1. Shri M. S. Kanungo (Cuttack) 2. Dr. D. N. Roychaudhuri (Calcutta) 3. Shri H. L. Sarkar (Delhi) 4. Dr. H. Swarup (Nainital)
Anthropology & Archaeology ...	1. Shri J. C. Sharma (Chandigarh) 2. Shri R. K. Gulati (Poona) 3. Dr. D. K. Sen (Lucknow) 4. Shri Nityananda Patnaik (Bhubaneswar)
Medical & Veterinary Sciences ...	1. Dr. P. C. Sen Gupta (Calcutta) 2. Dr. G. S. Biswal (Cuttack) 3. Dr. B. B. Roy (Calcutta) 4. Dr. S. R. Rao (Bombay)
Agricultural Sciences	1. Dr. B. N. Sahu (Bhubaneswar) 2. Shri R. S. Paul (Calcutta) 3. Dr. B. Chaudhury (New Delhi) 4. Dr. T. M. Das (Calcutta)
Physiology	1. Dr. R. N. Sen (Burla) 2. Dr. J. N. Maitra (Calcutta) 3. Dr. M. S. Chaudhry (Jabalpur) 4. Dr. A. K. Pal (Izatnagar)

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Psychology & Educational Sciences	1.	Dr. V. K. Kothurkar (Poona)
	2.	Dr. J. Das (Bhubaneswar)
	3.	Dr. E. I. George (Trivandrum)
	4.	Dr. R. G. Chatterjea (Calcutta)
Engineering & Metallurgy ...	1.	Dr. D. C. Tapadar (24-Parganas)
	2.	Dr. K. K. Majumdar (Bombay)
	3.	Dr. S. S. Banerjee (Varanasi)
	4.	Shri T. R. Shroff (Bombay)

Item 6—To announce the venue and the period of the Session to be held in January, 1963.

The President, Dr. B. Mukerji, announced that the request of the University of Delhi to hold the 50th (the Golden Jubilee) Session of the Indian Science Congress Association in Delhi was accepted, and that the Session would be held there from the 3rd to the 9th January, 1963.

Item 7—To adopt the Annual Report for 1961.

The General Secretary, Prof. B. C. Guha, informed the Committee that copies of the Annual Report had been distributed to the Members from the local office of the Association in Cuttack.

At the suggestion of the President, he invited attention to the main features of the Report. He referred to pages 4 and 9 of the Report detailing the proposals for commemorating the Golden Jubilee of the Science Congress and the Sectional programme of work of the Science Congress respectively.

Regarding the Golden Jubilee celebrations he made references to the creation of a Professorship and the publication of two special volumes, one on "Fifty Years of Science in India" and the other on the "History of the Indian Science Congress Association".

Mentioning the ratio between the number of papers submitted and those actually read in each Section at the last Session of the Science Congress, as given at page 9, Prof. Guha stated that the question of improving the standard of work done at different sections had been long engaging the attention of the Executive Committee. This was also discussed, Prof. Guha said, at the last meeting of the Council, in which some important decisions were taken to re-emphasise, among other things, that the Sectional Presidents might drop or alter the subjects of symposia already suggested by a previous Sectional Committee, for the sake of effective organisation of the same. The Council opined that at least a half-day should be allotted to each symposium (or a group discussion as it might be called), in which perhaps three or four persons only would be invited to present detailed papers on one particular topic and others would contribute to discussion round those papers. Also an advance programme of work covering both symposia and individual papers for each Section might be prepared by the Sectional President. In this connection he informed the Members that for the first time this year the President of the Section of Physics prepared an advance programme in respect of his Section and circulated the same to those having interest in physics, and this was reported to have brought about an improvement in the working of that Section.

The President, Dr. B. Mukerji, said that in addition to doing its best to improve the level of scientific work carried out at the Annual Session of the Science Congress, the Association now, with the opening of its new building and auditorium at the Headquarters station, directed its attention to achieving its objective of reaching science to the door of the general public by organising popular science lectures throughout the year. Such lectures were proposed to be organised in a number of centres, including Cuttack, to begin with. It was also proposed, Dr. Mukerji stated, to spend up to Rs. 100/- per lecture to enable the lecturer to meet the cost of preparing slides, etc. An application had been made to the

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Government of India for giving the necessary grants, and on their agreeing to the principles of organising the lectures, the work would be taken up in different centres. Meanwhile a beginning was already being made in the Headquarters station.

The President then invited Members to offer suggestions.

Dr. P. K. Bose said that he had only two points to mention: (1) More time should be allotted to the General President for reading his Address at the inauguration ceremony, and (2) if the meeting of the General Committee could be held a day earlier, more Members, than merely 100 or so out of a total of nearly 4,000, could be present.

Making a special reference to page 9 of the Report, Dr. P. K. Bose suggested that it would be easier to ascertain whether the position was improving or worsening if comparative figures in respect of presentation and reading of papers for three past years were given in a tabular form instead of the figures for only one year as given at present.

Referring to the question of organising popular science lectures, Dr. Bose stated that real benefits could accrue to those for whom these would be organised if a small committee could be constituted to prepare a schedule of such lectures.

Replying, the President, Dr. B. Mukerji, said that insofar as the time for delivering the General Presidential Address was concerned the present arrangement did not in any way detract from the prestige of the Association. He mentioned that at the last inauguration he himself was allowed 43 minutes to give his Address as against 5 minutes taken by the Vice-Chancellor, 3 minutes taken by the Governor and 2 minutes taken by the Chief Minister to deliver their respective speeches, and it was obvious that the President was treated with the needed distinction. He reminded Members that if the Association wanted to take science to the masses, the association of heads of Universities and States or leaders of people at its Annual Sessions had to be retained or even fostered, and from this angle, the present arrangement of holding the inauguration ceremony seemed to be the right thing to follow.

As regards the suggestion to advance the date of the meeting of the General Committee by a day, Dr. Mukerji stated that experience would indicate that the present date was the most suitable one, as when the Congress was to officially terminate on the 9th of January, 7th was not surely too late for convening the meeting of the General Committee, specially in view of the formalities that were to be complied with before the meeting was held.

Expressing his appreciation of the suggestion to constitute a small committee to prepare a panel of lectures, Dr. Mukerji informed Dr. P. K. Bose that this would be duly considered by the Executive Committee.

Dr. Mukerji agreed that in future comparative figures for three years in respect of presentation and reading of papers at the Science Congress might be given in the Annual Report.

Dr. S. K. Sircar stated that it appeared that the Annual Report was sought to be presented in an apologetic manner, and it looked as though a conscious effort was made to justify the use of grants.

With this observation, however, the President did not agree, opining that the Report was a narration of facts and in the matter of grants it was necessary to explain how the same were utilised.

Dr. S. K. Sirkar then referred to the Standing Committee for Popularisation of Science in India and wanted to know its activities. The Association's representative on that Committee, Prof. B. N. Prasad, narrated in brief the present position in relation to the work for which it was constituted under the auspices of the Council of Scientific and Industrial Research. Prof. Prasad agreed to write to the appropriate authority with a view to ascertaining what was proposed to be done by the Committee in the matter of popularisation of science in the country.

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On a point of enquiry about the staff gratuity fund, made by Dr. S. K. Sirkar, the General Secretary, Prof. B. C. Guha, informed him that the principles according to which gratuity should be paid to any member of the staff had not yet been decided, but the same would be formulated as early as possible after taking into consideration the practices followed in Universities, Railways and Government offices.

Dr. S. R. Sinha referred to the proposal for the creation of the Golden Jubilee Professorship and stated that it would be desirable to select persons for appointment to this Professorship according to the branches of science as per the Sections of the Association so that the Professorship might go to mathematics, statistics, physics, and so on by rotation.

The President, Dr. B. Mukerji, pointed out that although it was difficult to strictly allot the Professorship sectionwise, one after the other, attention would be paid to the main point of the suggestion, namely, that one branch of science might not be repeated in making the appointments. The details in this respect were still to be worked out, he stated, and the point raised by the Member would be kept in mind.

After some further discussion, the Annual Report for 1961 was adopted.

Item 8—Miscellaneous—

(A) To consider a letter dated the 6th January, 1962, from Shri M. S. Prasad on the question of discussing the problems of peace and the proper use of science.

Explaining in brief the background of the suggestion made by Shri M. S. Prasad, the President, Dr. B. Mukerji, moved the following resolution for consideration by the Committee, and the same was adopted unanimously :—

"The Indian Science Congress views with deep concern the continuing preparations for war involving the use of weapons of mass destruction and of nuclear weapons in particular, and urges upon all scientists of the world to strengthen their activities to ensure that the tremendous power created by science is not used for man's self-annihilation and is employed exclusively for the good of the entire human family. This Congress considers that scientific discoveries representing the majesty of the human mind make it for the first time possible in the long history of man to banish want, ignorance and disease from all parts of the world, and calls upon all scientists to help in the purposeful achievement of this great mission of science".

Before the termination of the meeting, the President, Dr. B. Mukerji, mentioned in some detail the efficient arrangements made for the Science Congress in Cuttack, and expressed, in behalf of the Association, its sincere thanks to the Vice-Chancellor of the Utkal University, Prof. P. Parija, the two Local Secretaries, Dr. B. Samantarai and Dr. R. N. Rath, the local Treasurer, Dr. A. K. Dey, officers in charge of transport and accommodation and the young volunteers, the combined efforts of whom made the Session a success. He expressed his appreciation and thanks for the help rendered by the Railway staff in Cuttack and Bhubaneswar. In this context he acknowledged the spirit of hospitality shown by the entire public and the press of Cuttack. He also mentioned the Association's indebtedness and offered his thanks to the Secretary in the Ministry of Scientific Research and Cultural Affairs, Prof. M. S. Thacker, and other officers and staff of that Ministry, particularly the Joint Secretary, Shri M. G. Raja Ram and the Deputy Secretary, Shri M. M. Kusari, for the personal care and pains they took in looking after the foreign delegates and making their tour arrangements.

The meeting then terminated with a vote of thanks to the Chair.

B. C. GUHA,
General Secretary,
Indian Science Congress Association.

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PROCEEDINGS OF THE MEETING OF THE COUNCIL

A meeting of the Council of the Indian Science Congress Association was held at 4-45 P.M. on Tuesday the 2nd January, 1962, in Ravenshaw College, Cuttack.

The following Members were present :—

1. Dr. B. Mukerji—President in the Chair
2. Dr. N. R. Dhar—Past President
3. Dr. P. L. Bhatnagar
4. Dr. G. D. Boaz
5. Prof. Nirmal Kumar Bose
6. Dr. V. Cadambe
7. Dr. C. Chandrasekaran
8. Dr. A. R. Chavan
9. Dr. A. K. Dey
10. Dr. G. C. Esh
11. Dr. Ramprasad Mitra
12. Dr. J. N. Mukherjee
13. Prof. S. R. Palit
14. Prof. P. Parija
15. Prof. B. N. Prasad
16. Dr. L. S. Ramaswami
17. Dr. K. P. Rode
18. Dr. P. K. Sen
19. Prof. T. R. Seshadri
20. Prof. S. M. Sircar
21. Dr. H. D. Srivastava
22. Prof. M. S. Thacker
23. Prof. J. Venkateswarlu
24. Dr. R. N. Rath—Local Secretary
25. Dr. P. K. Bose—Treasurer
26. Prof. B. C. Guha—General Secretary

Item 1—To confirm the minutes of the meeting of the Council held on the 2nd January, 1961.

The Members noted that the minutes of the meeting held on the 2nd January, 1961, had been sent to them along with the notice for the present meeting, and no comments received.

Confirmed.

Item 2—To consider the Annual Report for 1961.

The General Secretary, Prof. B. C. Guha, informed the Members that copies of the Annual Report had been circulated to all of them and no comments received. He stated that, as usual, the report contained a statement of facts. Speaking about the important events he referred to pages 9 and 11 of the Report, mentioning that a brief review of work done during the last Science Congress and details in respect of the opening of the building and the auditorium that took place on the 8th December, 1961, were given on these pages.

In this connection he referred to the question of organising the sectional work at the Science Congress in a more effective manner, and suggested that it would be very helpful if detailed programmes of Sections could be prepared by the Sectional Presidents in advance and adhered to as far as practicable. He informed the Council in this context that perhaps for the first time the President of the Section of Physics had prepared such an advance programme in respect of his Section and circulated this to all the Members having interest in physics. It was true that in the absence of information as to who amongst the authors of papers would be present to read them, any advance programme would be tentative; but it would be worthwhile to collect information in advance about actual attendance of contributors of papers at the Session and prepare a programme for implementation.

Dr. J. N. Mukherjee, a senior Past General President and a past General Secretary of the Association, stated that in the past authors of papers were usually

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present at the Science Congress and the senior amongst them always made room for the junior ones to enable the latter to read their papers. It was also the practice, he stated, that if more than one paper was contributed by an author, he would read only one of them. He emphasised that as was done previously, none should be allowed to present more than two or three papers. He then enquired if the same practice was being followed.

Pointing to the necessity of making the reading of papers fruitful and interesting, Dr. J. N. Mukherjee said that the authors should come prepared with slides and diagrams. Formerly, he said, all these points were used to be conveyed to the Members by the Sectional Presidents.

Prof. B. C. Guha stated that broadly the practice as mentioned by Dr. J. N. Mukherjee, was being followed also at the present Sessions. Circulars too were issued by the Sectional Presidents to Members interested in the respective branches of science inviting them to present papers, in which the requirements about the number of papers that could be submitted singly or in joint authorship by each, etc., were described.

Dr. J. N. Muhkerjee pointed out that the instructions should be comprehensive, and it was desirable to note this for implementation in future.

Prof. T. R. Seshadri agreed with the suggestions made by Dr. J. N. Mukherjee, saying that the circular to be issued by the Sectional Presidents to authors should contain all the necessary details.

Referring to the question of preparing a Sectional programme in advance, the President of the Section of Chemistry, Prof. R. P. Mitra stated that as many of the authors did not themselves know up to almost the eleventh hour as to whether they would be permitted by their Universities or employers to attend the Science Congress, it might not be possible to ascertain as to who amongst them would be present at the Session, and naturally it would be difficult to prepare a programme, particularly in respect of the reading of papers, that could be given effect to without any dislocation.

Dr. L. S. Ramaswami, President of the Section of Zoology & Entomology, pointed out that in arranging a programme for reading of papers it was necessary to keep in mind the requirements of those who would come from very distant places and would like to return quickly after reading their papers.

The President, Dr. B. Mukerji, stated that if papers were to be usefully read, they should be taken up in groups according to broad divisions of subjects, and from this angle it would be difficult to accommodate individual requests for early reading of papers arising out of the necessity of their going away early. As a matter of fact, if the Members attending a Session did not stay at least for four or five days at the venue, no useful programme for sectional work could be prepared.

Prof. S. R. Palit referred to the present system of organising symposia allotting hardly more than an hour for each. He said that no useful purpose was served by holding such symposia, as a symposium to be effectively organised would require at least a full day. It might be desirable to consider if the number of symposia could be reduced so that only one or two symposia could be held in a section, but in a more fruitful manner, allotting a full day, or at least a half-day for each.

Dr. G. C. Esh, President of the Section of Physiology, expressed the same opinion as Prof. Palit, and so did Prof. R. P. Mitra.

Dr. P. L. Bhatnagar, President of the Section of Mathematics, and Dr. C. Chandrasekaran, President of the Section of Statistics also spoke in support of the suggestion made for alloting longer time to symposia.

Some of the Sectional Presidents described how poor the response to invitations for participating in symposia was, stating that in some cases the invitations did not evoke even a single reply. They opined that the symposia for which no reply

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was received from prospective participants, should have been omitted from the programme.

Dr. J. N. Mukherjee stated that for the type of symposia, or rather group discussions, as were organised at the Science Congress, one-to-two-hour did not seem to be insufficient. The Science Congress was meant for encouraging the younger workers, and it was not necessary to go in for any symposia on abstruse scientific subjects; the idea should be to provide a forum to them for discussion, and that could be effectively done if the subjects were chosen with care and discussions organised limiting each to four or five persons, and if this was done, there appeared to be no reason why an hour or two should not be sufficient for the purpose.

Prof. B. N. Prasad stated that the idea of fixing symposia in the afternoon was to allot the entire afternoon to the holding of the same, and at least two hours or more were usually available for the same. Besides, the Sectional Presidents were competent to continue the discussion the next or any other day, if necessary. As regards the symposia for which no response was received by the Sectional Presidents, these could be omitted if the Sectional Presidents informed the Headquarters office by the end of October advising the General Secretary to drop them.

The President, Dr. B. Mukerji, stated that the Sectional Presidents were authorised to alter or drop any symposium as suggested by a previous Sectional Committee, for the convenience of organising it, and naturally, they could at the very beginning choose such subjects, after giving due consideration to those suggested by the Sectional Committee, as they could effectively organise. This would go a long way in improving the position.

Prof. M. S. Thacker suggested that the entire question of organising symposia in an effective manner should be left to the discretion of the respective Presidents who were competent to do it themselves.

After some further discussion it was agreed—

(1) That the circular issued by Sectional Presidents to prospective contributors of papers should cover all the points relating to the limitation of the number of papers to be submitted singly or in joint authorship to two or three, desirability of coming prepared with slides, diagrams, etc., for reading the papers, convention of the junior authors being given preference over the senior ones in the matter of reading of papers, etc.

(2) That at least half-a-day be allotted to each symposium (or preferably a group discussion in which three or four invited speakers presented their papers and other contributed to the discussion around those papers) to be organised during a Science Congress and that it be made clear to the Sectional Presidents that they are competent to alter or drop any symposium or symposia suggested by the previous Sectional Committees.

(3) That the Sectional Presidents be requested to intimate by October each year the topics of symposia they would like to drop out of the suggested ones for want of response or for other reasons so that the same could be omitted from the Programme of the Session.

At this stage Prof. M. S. Thacker stated that the Science Congress met only once a year and for the rest of the year the organisation remained more or less static, and it would be worth considering how best it could engage itself in some wholesome work for advancing the cause of science. In this context he referred to the work being done by the British Association for the Advancement of Science in the U. K. where three thousand teachers were reported to have volunteered to help spread scientific education amongst school children under the auspices of that Association.

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Dr. B. Mukerji said that the idea put forward by Prof. M. S. Thacker was very valuable, and he informed the Members that endeavours were already afoot to move in the direction of getting the Association engaged all the year round in doing some useful work.

The General Secretary, Prof. B. C. Guha, said that the Executive Committee had already approved a scheme for organising popular science lectures in different towns including Cuttack, to begin with, under the auspices of the Association with a view to disseminating scientific knowledge and developing the temper of science in the country. The Government of India were being approached at the start to sanction Rs. 5,000/- per year to enable the Association to implement the scheme. He described how the auditorium at Calcutta was proposed to be utilised and how this use was initiated on the very day of the opening of the auditorium on the 8th December last with two educative lectures attended with film shows.

After some more discussion the General President, Dr. B. Mukerji, undertook to formulate a scheme of work for the Association and circulate the same to the members of the Council for consideration and comments.

At this stage Dr. J. N. Mukherjee referred to the obituary note as given in the Annual Report, asd suggested that, if feasible, brief obituary notices giving some details about the persons concerned might be given in future, and this was accepted by the Council.

Before the termination of the meeting Dr. J. N. Mukherjee referred to the code of honour which enjoined on all scientists not to pass off others' work as their own. He and others cited some instances in this regard.

It was agreed that Dr. J. N. Mukherjee and Prof. P. Parija might be requested to prepare a note on the subject indicating concrete remedial measures which might be adopted.

The meeting then terminated with a vote of thanks to the Chair.

B. C. GUHA,
General Secretary,
Indian Science Congress Association.

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COMMITTEE ON SCIENCE & ITS SOCIAL RELATIONS

The Annual Meeting of the Committee was held in the Hall of Ravenshaw College, Utkal University, Cuttack, on the 4th January, 1962, at 2-30 P.M. under the Chairmanship of the General President, Dr. B. Mukerji, Prof. N. K. Bose acted as the Convener, and the minutes were rerorded by Prof. K. L. Malhotra.

The following were present :—

1. Dr. B. Mukerji—in the Chair
2. Dr. N. R. Dhar
3. Prof. B. C. Guha
4. Prof. P. K. Bose
5. Prof. N. K. Bose
6. Prof. K. L. Malhotra
7. Shri S. K. Dey

1. The minutes of the meeting of the Committee held on 4th January, 1961, were read and adopted.

2. It was agreed that a symposium "Science and Human Progress : the Indian Scene" should be held during the Session of the Science Congress in 1963.

3. In addition to the ex-officio Members, the following were elected Members of the Committee on Science and its Social Relations :

(1) Dr. B. Mukerji (Lucknow), (2) Dr. N. R. Dhar (Allahabad), (3) Prof. B. C. Guha (Calcutta), (4) Prof. P. K. Bose (Calcutta), (5) Prof. N. K. Bose (Calcutta), (6) Dr. A. K. Dey (Calcutta), (7) Prof. S. R. Palit (Jadavpur), (8) Prof. Indra Sen (Pondicherry), (9) Dr. S. H. Zaheer (Hyderabad), (10) Shri A. Rahman (Mysore), (11) Prof. N. Mukerji (Bombay), (12) Prof. M. S. Thacker (New Delhi), (13) Prof. M. P. Madan (Lucknow), (14) Prof. R. Ray (Jadavpur), (15) Dr. D. D. Kosambi (Bombay), (16) Mrs. C. Bose (Calcutta), (17) Dr. M. P. Vashney (Kharagpur), (18) Dr. S. K. Chatterji (Calcutta), (19) Dr. (Miss) B. Borgenza (Bombay), (20) Dr. M. H. Desai (Delhi), (21) Mrs. I. C. Karve (Poona), (22) Dr. S. Jalota (Chandigarh), (23) Shri S. K. Dey (Calcutta), (24) Dr. K. C. Ray-Chaudhury (Aligarh), (25) Prof. S. Bose (New Delhi), (26) Dr. A. C. Ukil (Calcutta) and (27) Prof. K. L. Malhotra (New Delhi)—Convener.

Prof. K. L. Malhotra (New Delhi), was elected as the Convener of the Committee from the year 1962, i.e., from 1st February, 1962.

4. It was suggested that ways and means be thought of implementing the aims and objects of this Committee instead of merely holding a symposium every year.

As a result of discussion, it was unanimously decided that popular lectures on various aspects of science and its social relations, be arranged in different places in the country during the year. Accordingly it was agreed to hold such lectures in different zones and the following places were selected :

(1) Calcutta, (2) Bombay or Poona, (3) Madras or Mysore, (4) Delhi, (5) Lucknow and (6) Allahabad.

The following subjects for the lectures were suggested and agreed upon :—

(1) Science and Caste System
(2) Science and Astrology
(3) Introducing Science in Schools

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It was further decided that in these lectures films, audio-visual aids, demonstrations, etc. be made use of.

It was also resolved that the lecturer whose lectures would be approved for the purpose be paid an honorarium of Rs. 100/- only per lecture as contribution towards the cost of the aids used.

Dr. B. Mukerji remarked that he would take all the steps necessary for the implementation of the above scheme during his tenure of General Presidentship.

The meeting terminated at 3-30 P.M. with a vote of thanks to the Chair, and Prof. N. K. Bose, the retiring Convener.

Sd/- K. L. MALHOTRA

Sd/- N. K. BOSE
Convener.

While adopting the above report at the meeting held on the 7th January, 1962, the Executive Committee appointed Prof. N. K. Bose as Chairman of the Committee on Science and its Social Relations.

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ANNUAL REPORT OF THE EXECUTIVE COMMITTEE OF THE INDIAN SCIENCE CONGRESS ASSOCIATION 1961

INTRODUCTION

As indicated in its Annual Report for the preceding year, the Association has, after a period of sharp rise in membership, entered a phase of consolidation, and this has been noticeable also during 1961. The last Science Congress was held in Roorkee, a traditionally known centre of engineering education but of lesser importance as a town than Bombay, Delhi and Madras in which the previous three Sessions had been held, and naturally there was a minor decline in membership. But, there is no appreciable change in the number of Members enrolled during the year under review despite the fact that another small town, namely Cuttack, is the venue of the Science Congress for 1962. This one single feature is indicative of the popularity of the Association among scientists and lay men interested in the advancement of science in India, which in retrospect is the measure of the useful work being done by the Association in awakening the general urge to take to the study of science and its application.

THE 48TH SESSION

Inaugurated by the President of India, Dr. Rajendra Prasad, the 48th Session of the Indian Science Congress was held in Roorkee under the auspices of the University of Roorkee from the 3rd to the 9th January, 1961. The inauguration was held at 10 A.M. on Tuesday the 3rd January, 1961, in the University Campus. About 3,000 visitors including about 1,500 delegates from different parts of the country as also 20 visiting scientists from abroad were present.

The Chancellor of the University of Roorkee and the Governor of Uttar Pradesh, Dr. B. Ramakrishna Rao, welcomed the foreign scientists, the delegates to the Indian Science Congress and visitors, through a short and attractive speech. Thereafter the Vice-Chancellor of the University of Roorkee, Prof. K. N. Kathpalia, delivered a welcome address. At the request of Dr. N. R. Dhar, the President of the Association, who presided over the function, the President of India, Dr. Rajendra Prasad, then inaugurated the Session of the Science Congress exhorting the scientists to serve mankind by removing the cobweb of ignorance and misery from the world. The President, Dr. N. R. Dhar, delivered his address with experimental demonstration on the loss of nitrogen from land fertilised with ammonium sulphate. Before the ceremony came to a close the guests from abroad were introduced to the audience by the Foreign Secretary of the Association, Prof. M. S. Thacker.

During the Session the thirteen Sections met every day when papers were read, discussions and symposia held and special and popular lectures delivered.

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In accordance with the usual practice an exhibition of scientific apparatus and instruments, etc., was organised in which many well-known dealers and manufacturers of chemicals, apparatus and instruments as also publishers of scientific literature participated.

OBITUARY

With profound regret the Executive Committee has to mention the death of one of the most distinguished of its past General Presidents, Prof. K. S. Krishnan, and to report with a deep sense of sorrow the deaths of the following Members who were eminent in their respective lines of specialisation: (1) Shri A. M. N. Ghosh, (2) Shri N. L. Dutt, (3) Dr. Subodh Mitra, and (4) Dr. A. N. Chatterjee.

Prof. K. S. Krishnan as also the other four scientists took active interest in the affairs of the Association till they breathed their last. Prof. Krishnan, who presided over the Science Congress held in Allahabad in January, 1949, was an ex-officio Member of the Council and a Member of the Executive Committee at the time of his passing away. He was not only an eminent scientist and an outstanding organiser but a person of great culture.

The other four were past Sectional Presidents of the Association. Shri A. M. N. Ghosh, who was a reputed geologist of India, presided over the Section of Geology & Geography at the Science Congress held in Agra in January, 1956, while Shri N. L. Dutt, who was an expert in agricultural science was the President of the Section of Agricultural Sciences at the Science Congress held in Delhi in January, 1947, and Dr. Subodh Mitra, who was a cancer specialist and an outstanding gynaecologist, presided over the Section of Medical & Veterinary Sciences during the Science Congress held in Agra in January, 1956. Dr. A. N. Chatterjee presided over the Section of Anthropology and Archaeology at the Science Congress held in Patna in January, 1948.

GENERAL COMMITTEE MEETING

The meeting of the General Committee was held at 3-30 P.M. on the 7th January, 1961, in the New Chemistry Building, University of Roorkee, Roorkee, with the President of the Association, Dr. N. R. Dhar, in the Chair. It was announced at this meeting that Prof. D. S. Kothari, Chairman, University Grants Commission, who was Professor & Head of the Department of Physics, University of Delhi, at the time, was elected as the General President of the Association for the Golden Jubilee Session of the Science Congress to be held in January, 1963. It was also recalled in this connection that Dr. B. Mukerji, Director, Central Drug Research Institute, Lucknow, would assume office as the President of the Association on the 1st February, 1961. That the invitation of the Utkal University to hold the 49th Session of the Indian Science Congress under the auspices of that University in Cuttack had been accepted, was announced at this meeting. The Committee decided at this meeting on the recommendation of the Executive Committee and the Council that the existing practice of election of Sectional Presidents or Recorders through the system of single transferable vote be replaced by the procedure of election by a simple majority of votes from 1961-62.

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COUNCIL MEETING

The Council of the Association met at 4-30 P.M. on Monday the 2nd January, 1961, in the New Chemistry Building, University of Roorkee, Roorkee, under the Chairmanship of Dr. N. R. Dhar. At this meeting the Members endorsed the recommendation of the Executive Committee to revert to the practice of election of Sectional Presidents and Recorders by a simple majority of votes, which, as stated earlier, was accepted by the General Committee.

COMMITTEES AND COMMITTEE MEETINGS

1. *Executive Committee* :—The Executive Committee of the Association met six times from the beginning of January, 1961. The policy about inviting foreign scientists was reviewed at a meeting of the Committee held on the 16th February, 1961, and it was decided that those national scientific societies abroad which were invited by the Indian Science Congress Association in 1959-60 to depute delegates to attend the Science Congress, be invited to send representatives, not exceeding two each, except the U.S.S.R. Academy of Sciences which might be asked to send up to five representatives, to the 49th Session of the Indian Science Congress to be held in Cuttack. In this connection it was decided at a later meeting held on the 17th July, 1961, that some research councils/academies, if in existence, of the newly constituted countries be also invited to send delegates, not exceeding two in each case, to the forthcoming Science Congress. At the First Statutory Meeting held on the 10th May, 1961, the recommendations made by the Golden Jubilee Committee were accepted and it was agreed to create a Professorship to be known as the Golden Jubilee Professorship, at the Association, and to bring out the following two publications: (1) "Fifty Years of Science in India" (with emphasis on work done during the past twenty-five years), and (2) "History of the Indian Science Congress Association" (with short biographical notes on the past General Presidents and obituary notices in detail in respect of the dead amongst them). The Members agreed at another meeting of this Committee held on the 17th July, 1961, that the Standing Committee for Visiting Scientists, which was constituted annually for some years past on the strength of a decision of the Executive Committee, be discontinued, its function of selecting foreign scientists for invitation automatically devolving on the Executive Committee.

2. *International Relations Committee* :—The International Relations Committee for 1961-62 was constituted as follows :—

Dr. B. Mukerji—President of the year—Chairman
Dr. N. R. Dhar—Past President
Prof. D. S. Kothari—President-Elect
Prof. M. S. Thacker—Foreign Secretary
Prof. S. N. Bose—Member of the Executive Committee
Shri M. G. Raja Ram—Representative of the Government of India
Dr. P. K. Bose—Treasurer
Prof. B. C. Guha, Prof. P. S. Gill } General Secretaries

3. *Publication Committee* :—A Publication Committee was constituted during the year in accordance with Regulation III of the Association to

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help the General Secretary (Headquarters) in matters relating to the publications of the Association. The Committee was constituted as follows: (1) Dr. M. C. Chaki, Member, Sectional Committee, Section of Mathematics ; (2) Prof. P. C. Mahalanobis, Senior Past President, Section of Statistics ; (3) Dr. A. K. Saha, Member, Sectional Committee, Section of Physics ; (4) Dr. J. N. Mukherjee, Senior Past President, Section of Chemistry ; (5) Dr. S. Sen, Member, Sectional Committee, Section of Geology & Geography ; (6) Dr. K. Biswas, Senior Past President, Section of Botany ; (7) Dr. Ashok Ghosh, Recorder, Section of Zoology & Entomology ; (8) Prof. K. P. Chattopadhyay, Senior Past President, Section of Anthropology & Archaeology ; (9) Prof. J. C. Banerjea, President, Section of Medical & Veterinary Sciences ; (10) Prof. P. K. Sen, President, Section of Agricultural Sciences ; (11) Dr. G. C. Esh, President, Section of Physiology ; (12) Dr. R. Chatterjee, Member, Sectional Committee, Section of Psychology & Educational Sciences ; and (13) Prof. J. K. Choudhury, Recorder, Section of Engineering & Metallurgy.

4. *Golden Jubilee Committee* :—As already pointed out, the Golden Jubilee Committee has made certain recommendations in respect of the ways and means to commemorate the Golden Jubilee and the same have been accepted by the Executive Committee. The following excerpts from the minutes of a meeting of this Committee held on the 10th May, 1961, merit reproduction :—

"After some discussion the Committee arrived at the following conclusions :

(A) A Professorship to be known as the "Golden Jubilee Professorship" be created at the Association of commemorate the Golden Jubilee of the Science Congress.

(B) It should be open to Indians only, and its tenure should be limited to one to two years without any option for a renewal of tenure.

(C) It may be for any discipline of science including the subject of history and philosophy of science.

(D) It should carry a salary of Rs. 2,500/- per month or Rs. 30,000/- per year, and secretarial/technical assistance, books, travelling, incidental, etc., may be allowed up to a total value of Rs. 12,000/- per annum.

(E) The Government of India should be moved to sanction a recurring grant of Rs. 42,000/- per year with effect from 1962-63 to enable the Association to meet the cost involved in creating the Professorship.

The Committee then discussed the feasibility of undertaking the publication of some special volumes, and agreed that steps be taken to bring out the following publications on the occasion of the Golden Jubilee : (1) *Fifty Years of Science in India* (with emphasis on work done during the past twentyfive years) in as many different parts as might be necessary, and (2) *History of the Indian Science Congress Association* (with short biographical notes on the past General Presidents and obituary notices in detail in respect of the dead amongst them)".

5. *Finance Committee* :—The Finance Committee with Prof. P. B. Sen, Head of the Department of Physiology, University College of Science & Technology, Calcutta, as the co-opted Member, met once on the 17th July, 1961, and considered among other things the audited state-

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ment of accounts of the Association for 1960-61, the inspection report submitted by Government Audit after test-check of accounts of the Association for 1959-60, and the budget estimate of the Association for 1962-63.

INTER-RELATION WITH SCIENTISTS AND SCIENTIFIC SOCIETIES IN INDIA AND ABROAD

(A) Participation of Scientists from Abroad

In accordance with the revised policy of the Association only a limited number of scientific academies abroad were invited to send representatives to the 48th Session of the Science Congress. Besides the delegates sent by academies, there were a few foreign scientists who happened to be in India at the time of the Session and attended the Science Congress on invitation. There were twenty foreign scientists in all, and among them one was from Canada, one from Ceylon, three from France, one from Poland, four from the U.K., five from the U.S.A., three from the U.S.S.R., and one from Yugoslavia. The U.N.E.S.C.O. also sent two representatives to attend the Congress. A complete list of foreign delegates is given in Appendix A.

Some of the foreign delegates delivered lectures, both popular and special, at the Science Congress. It may be mentioned here that a few Indian scientists too, including the General President of the Association, Dr. N. R. Dhar, gave talks on popular scientific topics. The following is the list of popular lectures delivered at the Session in Roorkee :—

1. "Plants, History & Politics"
   by Prof. P. Maheshwari
2. "Evolution from H. atom to man"
   by Prof. H. Shapley
3. "Productivity of Ponds in high levels"
   by Dr. J. R. Olive
4. "The Infra-red spectrum and its applications"
   by Prof. J. Lecomte
5. "World Food Situation & its improvement"
   by Dr. N. R. Dhar
6. "The Values and dangers of Steroid Therapy"
   by Dr. R. F. Farquharson
7. "Impact of Science on Society"
   by Dr. W. E. Swinton
8. "Earthquake Engineering Problems in India"
   by Dr. Jai Krishna

The special lectures were delivered at different Sections of the Congress according to the topics covered. Discussions followed in almost all cases after the delivery of these lectures, and this provided an opportunity to the younger scientists to exchange views with the foreign experts.

Prof. Zorski of Poland delivered a talk on "Projective Theory of the Continuum Mechanics" at the Section of Mathematics. Prof. Mischenko of the U.S.S.R. Academy of Sciences also gave a lecture on "The Maximum Principle in the Theory of Optional Processes of Control" at this Section.

In the Section of Chemistry, Prof. A. H. Beckett (U.K.) gave a discourse on "Three Dimensional Approach to Drug Design", and eluci-

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dated the points raised by Members after hearing the talk. Prof. J. Lecomte (France), who represented the Academy des Science, Paris, dclivered two lectures in this Section, one on the "Infra-red spectrum and organic chemistry" and the other on the "Equipment of the Infra-red Department in the Laboratory of Physical Research in Sorbonne".

At a joint session of the Sections of Medical & Veterinary Sciences and Physiology, Dr. R. F. Farquharson, who was the delegate from the National Research Council, Canada, demonstrated the various clinical abnormalities occurring as a result of pituitary disorders, with the help of slides. Describing the history of medical research in Canada, Dr. Farquharson also opened the symposium on "Scope, facilities and materials for medical research in India" held in the former Section. Prof. K. Todorovic of Yugoslavia also took part in this discussion and narrated how small-pox was eradicated from his country and how the cases of meningitis were reduced to the minimum.

Academician Kostenko, who led the delegation from the U.S.S.R. Academy of Sciences, read a paper on "Scientific Problems involved in the Construction of giant Power System in U.S.S.R.", in the Section of Engineering & Metallurgy. A lively discussion followed and the Members appreciated that the bearing the discourse should have on the current power problems in India could not be over-emphasised.

The representatives sent by academies undertook tours to different educational and research centres in India after the Session was over. A list of institutions and establishments which the scientists had occasion to visit is given in Appendix B.

At many of the centres of their visit the foreign delegates delivered lectures or held discussion with the local scientific workers. The following is the list of lectures delivered by scientists at different institutions they visited :

Stereochemical Factors in Biological Action—Delivered at the Bengal Immunity Research Institute, Calcutta.	By Dr. A. H. Beckett
Biological Fixation of Nitrogen— Delivered at the University of Delhi, Delhi, and the Central Drug Research Institute, Lucknow.	By Prof. R. H. Burris
Dangers and values of Cortisone treatment—Delivered at the All-India Institute of Medical Sciences, New Delhi ; and (2) The Value and danger of steroid therapy—Delivered at the Central Drug Research Institute, Lucknow.	By Dr. R. F. Farquharson
Mechanism of Memory—Delivered at the All-India Institute of Medical Sciences, New Delhi ; (2) The Fixation of Experience—Delivered at the Central Drug Research Institute, Lucknow ; and (3) Brain and Behaviour—Delivered at Seth G. S. Medical College, Bombay.	By Dr. R. W. Gerard

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Fourier Concepts in Optics—Delivered at the National Physical Laboratory, New Delhi, and the Indian Association for the Cultivation of Science, Jadavpur ; (2) Optical Hyperfine spectroscopy and some of its applications—Delivered at the Tata Institute of Fundamental Research, Bombay ; and (3) Fourier Spectroscopy—Delivered at the Indian Association for the Cultivation of Science, Jadavpur.	By Prof. P. Jacquinot
Physiology of Growth—Delivered at the Central Drug Research Institute, Lucknow.	By Prof. H. Krueger
The infra-red spectrum and organic chemistry—Delivered at the University of Delhi, Delhi ; (2) Infra-red spectrum—Some results and the equipment in the University of Paris—Delivered at the Indian Statistical Institute, Calcutta ; (3) Infra-red Spectroscopy—Delivered at the Tata Institute of Fundamental Research, Bombay ; (4) Application of Infra-red absorption and reflection spectra for the determination of molecular structure—Delivered at the Jadavpur University, Jadavpur ; and (5) Recent Researches in Infra-red Spectra—Delivered at the Indian Institute of Science, Bangalore.	By Prof. J. Lecomte
Genetic Regulatory Mechanisms in Enzyme Synthesis—Delivered at the Indian Statistical Institute, Calcutta.	By Prof. J. Monod
Cosmography—Delivered at the University of Delhi, Delhi ; (2) Evolution from H to Homo Sapiens—Delivered at the Indian Association for the Cultivation of Science, Jadavpur ; and (3) Inorganic and organic evolution—Delivered at the Central Drug Research Institute, Lucknow.	By Prof. H. Shapley
Catalytic alkylation of tetralin with n-alkenes and primary alcohols ; and (2) Reactions of cyclanes and alkanes in the presence of metals of gr. VIII of the periodic system under hydrogen pressure—Delivered at the University College of Science & Technology, Calcutta.	By Mr. N. I. Shuikin

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(B) National Institute of Sciences of India

Dr. N. R. Dhar, President of the Association for 1960-61, and Prof. B. C. Guha, General Secretary (Headquarters), represented the Association as an Additional Vice-President and an Additional Member respectively on the Council of the National Institute of Sciences of India during 1961.

(C) Indian Council of Medical Research

Prof. B. C. Guha, General Secretary (Headquarters) of the Association was appointed to represent the Indian Science Congress Association on the Governing Body of the Indian Council of Medical Research for three years from the 10th March, 1961.

(D) Central Advisory Board of Anthropology

Dr. A. Aiyappan, Professor & Head of the Department of Anthropology, Utkal University, Cuttack, represented the Indian Science Congress Association on the Central Advisory Board of Anthropology until October, 1961, when Dr. (Mrs.) I. Karve (Poona) was selected to represent the Association on that Board.

(E) All-India Institute of Medical Sciences

Prof. P. Sen, Professor of Medical Entomology, School of Tropical Medicine, Calcutta, continued to be the representative of the Indian Science Congress Association on the All-India Institute of Medical Sciences until November, 1961, when Dr. P. K. Bose, Bose Institute, Calcutta, was selected to be the Association's representative on that Institute for five years.

(F) Standing Committee for Popularisation of Science in India

Prof. B. N. Prasad, a Member of the Executive Committee, continued to be the representative of the Indian Science Congress Association on the Standing Committee for Popularisation of Science in India constituted under the auspices of the Council of Scientific & Industrial Research, New Delhi.

(G) Indian Council for Cultural Affairs

Dr. B. Mukerji, President of the Association, was selected to represent the Indian Science Congress Association on the General Assembly of the Indian Council for Cultural Affairs for a period of four years from 1961.

(H) British Association for the Advancement of Science

Dr. B. Mukerji, President, and Prof. P. S. Gill, General Secretary (Outstation) of the Association, represented the Indian Science Congress Association at the last meeting of the British Association for the Advancement of Science held in Norwich from the 30th August to the 6th September, 1961.

(I) Ceylon Association for the Advancement of Science

Dr. B. Mukerji, President of the Association, attended the last Annual Meeting of the Ceylon Association for the Advancement of Science held in Colombo from the 23rd to the 25th November, 1961 in behalf of the Indian Science Congress Association.

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SECTIONAL WORK AT 48TH SESSION

The details in respect of the participation of foreign scientists in the scientific programme of different Sections during the last Science Congress have been described in brief in the foregoing pages. The Sections usually met from the day following the inauguration almost to the last day of the Session, i.e., from the 4th to the 9th January, 1961. Most of the thirteen Sections were busy till the last day, although in one or two cases the work at the Sections came to a close a little earlier. The Sectional Presidential addresses were delivered at the respective Sections in the morning of the 4th January. Thereafter the mornings were utilised mostly in reading of papers, while symposia and joint discussions were usually held in the afternoon from the 4th January. The subjects of symposia and joint discussions held and titles of lectures delivered have been printed in Part I of the Proceedings, and notes on symposia organised have been published in Part IV of the Proceedings of the 48th Science Congress. In this connection it may also be mentioned that all the Presidential Addresses delivered at the last Science Congress have been published in Part II of the aforesaid Proceedings.

Including abstracts of 85 late papers, in all abstracts of 1,526 papers, submitted by Members and Sessional Members from different parts of the country, either direct or through institutions, for reading in the thirteen Sections at the last Science Congress, were published in the Proceedings (Part III and IV). Of them, 405 papers were actually read. Section-wise, the following was the position of papers submitted and read, the number of papers read being shown in brackets: Mathematics—35(25) ; Statistics—46(20) ; Physics—133(55) ; Chemistry—350(66) ; Geology & Geography—125(16) ; Botany—278(30) ; Zoology & Entomology—154(11) ; Anthropology & Archaeology—34(29) ; Medical & Veterinary Sciences—50(27) ; Agricultural Sciences—131(60) ; Physiology—82(22) ; Psychology & Educational Sciences—76(24) ; Engineering & Metallurgy—32(20). It may perhaps be worthwhile to mention that only about 27 per cent of the total number of approved papers were actually read at the Session.

In connection with the work conducted at different Sections it is necessary to refer to the activities of the Committee on Science & its Social Relations. This Committee met at 3 P.M. on the 4th January, 1961, with Dr. N. R. Dhar in the Chair. A symposium on "Science, Technology and Social Changes in India" was held under his chairmanship. It was decided at the aforesaid meeting that a symposium on "Science, Freedom and Human Progress" should be organised during the ensuing Session of the Indian Science Congress.

MEMBERSHIP OF THE ASSOCIATION

The following table provides a comparative picture of the number of Members of different categories enrolled during the last four Sessions and in respect of the forthcoming one :—

	45th Session (1957-58)	46th Session (1958-59)	47th Session (1959-60)	48th Session (1960-61)	*49th Session (1961-62)
Life Member	118	127	142	156	163
Member	3,043	3,548	4,208	3,885	3,742
Sessional Member ...	661	785	777	410	308
Student Member ...	429	406	511	216	173

* Up to 15th December, 1961.

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OFFICE BEARERS

Dr. B. Mukerji, Director, Central Drug Research Institute, Lucknow, took over charge as the General President of the Association with effect from the 1st February, 1961. Prof. B. C. Guha continued to be the General Secretary (Headquarters) during the year while Prof. P. S. Gill, who was elected General Secretary (Outstation) for a period of three years, assumed the office on the 1st February, 1961. Dr. P. K. Bose continued to be the Treasurer of the Association.

FINANCIAL POSITION

The income and expenditure accounts of the Association for the year ended the 31st March, 1961, other than those on the foreign scientists' account, revealed a shortfall of income over expenditure of Rs. 1,051·25nP. This mainly happened as a result of non-receipt of a promised grant of Rs. 1,000/- from the National Institute of Sciences of India. On the income side there was a decline in receipts by way of membership subscription, and the reason for this could be traced to the Session being held in the small town of Roorkee. The shortfall in income on membership subscription account was offset by an increased Government grant, which was raised from Rs. 42,800/- in 1959-60 to Rs. 57,200/- in 1960-61.

The foreign scientists' account disclosed a deficit of Rs. 9,081·10nP. But the Government of India have since sanctioned Rs. 14,000/- which has not only enabled the Association to meet the deficit but resulted in a surplus balance to be spent on foreign scientists' account during the 49th Science Congress.

The current liability of Rs. 17,364·05nP was mainly due to outstanding bills in respect of expenses incurred on foreign scientists amounting to Rs. 14,569·98nP—Rs. 4,813·75nP for 1959-60 and Rs. 9,756·23nP for the following year. The balance of Rs. 2,794·07nP represented the municipal taxes due.

It may be mentioned here that in consideration of the suggestions made by Members at the last meeting of the General Committee, most of the available balances standing to the credit of Reserve Fund, Gratuity Fund and Provident Fund have been invested in 4% Ten-Year Treasury Savings Certificates.

The position in so far as the recurring side of actual income and expenditure is concerned, is shown below :—

	Expenditure	Income	Deficit
1st April, 1959 to 31st March, 1960 ...	1,28,338·16	1,26,654·66	1,683·50
1st April, 1960 to 31st March, 1961 ...	1,31,734·32	1,30,683·07	1,051·25

The audited statements of accounts of the Association for the year ended the 31st March, 1961 including those relating to the Provident Fund, and the budget estimates for two subsequent years are given in appendices C, D, E. and F.

Before the review of the financial side is brought to a close it may be stated for information of the Members that for the first time in the history of the Association a Government audit was made of the accounts of the

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Association for 1959-60 with a view to test-checking the recurring Government grants-in-aid received during the year as the same, including grants on foreign scientists' account, exceeded Rs. 1 lakh.

BUILDING AND AUDITORIUM OPENED

The newly constructed building and auditorium of the Association at 64, Dilkhusa Street, Calcutta-17, were formally opened by Dr. B. C. Roy, Chief Minister, West Bengal, at a function organised at 9 A.M. on the 8th December, 1961, at which all the Members and Sessional Members were invited to be present. Prof. M. S. Thacker, Director-General, Council of Scientific & Industrial Research and Secretary to the Government of India, Ministry of Scientific Research & Cultural Affairs, delivered a special address on the occasion dedicating the buildings to science. The Members of the Council were specially invited to attend, and many of the senior past General Presidents and most of the Sectional Presidents of the current year, were among those who took part in the function. A gallery of photographs of the past General Presidents was organised on this occasion, and a brochure containing a brief history of the Association was published and distributed to the audience.

In connection with the opening of the buildings, Messrs. Bengal Chemical & Pharmaceutical Works Ltd. presented a framed picture of Sir P. C. Ray to the Association, and arranged to entertain the guests to tea after the ceremony was over. Messrs. Bengal Immunity Co. Ltd. too presented on the occasion a framed portrait of Dr. B. C. Roy in oil painting to the Association. Messrs. Calcutta Chemical Co. Ltd. gave a lunch on that day to selected guests including such members of the Council as could be present.

The Ministry of Scientific Research & Cultural Affairs of the Government of India have very kindly sanctioned a grant of Rs. 30,000/- for furnishing and equipping the auditorium, which has got sitting accommodation for 402 persons. While it has already been fitted with the required number of chairs and other furniture like a special table and a few special chairs for the dais, equipments like epidiascope, etc., are being arranged to be procured.

Messrs. Philips India Ltd. have made a gift of a complete set of public address equipment to the Association, and they have fitted the same in the auditorium. This was acknowledged with sincere thanks at the aforesaid function in respect of the opening of the buildings. The use for which the auditorium has been built was initiated on the very day of its opening on the 8th December with two popular science lectures, both illustrated by films, one on "Juang of Orissa", delivered by Prof. N. K. Bose, Director, Anthropological Survey of India, Calcutta, and the other on "Darjeeling and Sikkim Flowers", delivered by Dr. K. Biswas, Director, Medicinal Plants, West Bengal, and Ex-Superintendent, Indian Botanical Gardens, Howrah.

ACKNOWLEDGEMENT

The Committee is grateful to the Ministry of Scientific Research & Cultural Affairs, Government of India, for the grants they have made available to enable the Association to meet its financial obligations.

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The Committee expresses its thanks to Prof. M. S. Thacker, and through him, to the officers and staff of the Ministry of Scientific Research & Cultural Affairs as it was with their help that the arrangements for the stay and travel in India of the foreign scientists who attended the last Science Congress in Roorkee, could be made to their satisfaction.

The Association is deeply thankful to the Sectional Presidents, Sectional Recorders and members of the Sectional Committees for doing their utmost in carrying the scientific programme of work at the last Session to a successful end.

The Committee places on record its sense of obligation to the Foreign Secretary, Prof. M. S. Thacker, whose services in the arrangement of the visit of foreign scientists were of inestimable value to the Association.

The Committee expresses its sincere appreciation of the help extended by members of the Council as also other members of this Association in the conduct of work all through the year.

The Association expresses its indebtedness to organisations like Philips India Ltd., Bengal Chemical & Pharmaceutical Works Ltd., Bengal Immunity Co. Ltd., and Calcutta Chemical Co. Ltd., which, as mentioned earlier, contributed materially to make the ceremony in respect of the opening of the buildings of the Association, fruitful and pleasant.

Lastly, the Committee records its appreciation of the work done by the staff of the Association.

B. C. Guha
P. S. Gill

General Secretaries,
On behalf of the Executive Committee of
the Indian Science Congress Association.

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APPENDICES

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APPENDIX A

INDIAN SCIENCE CONGRESS ASSOCIATION

List of Visiting Scientists from abroad, who attended the 48th Indian Science Congress held in Roorkee from the 3rd to the 9th January, 1961.

Canada

Dr. R. F. Farquharson—National Research Council
Mrs. Farquharson

Ceylon

Dr. K. Arumugam—Ceylon Associa- for the Advancement of Science

France

Mon. J. Lecomte, Mrs. Lecomte, Prof. J. Monod, Prof. P. Jacquinot — Academie des Sciences

Poland

Prof. H. Zorski

U. K.

Dr. W. E. Swinton—British Association for the Advancement of Science
Dr. H. R. Ambler
Dr. A. H. Beckett
Mr. H. R. Mills

U. S. A.

Dr. R. W. Gerard, Mrs. Gerard — National Academy of Sciences
Prof. H. Shapley
Prof. H. Krueger
Mrs. Krueger
Prof. R. H. Burris
Dr. J. R. Olive

U. S. S. R.

Academician Kostenko, Mrs. Kostenko, Prof Mischenko, Mr. Shuikin — U.S.S.R. Academy of Sciences

Yugoslavia

Prof. K. Todorovic

U.N.E.S.C.O.

Dr. R. H. Fritsch
Dr. H. Frederick

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APPENDIX B

INDIAN SCIENCE CONGRESS ASSOCIATION

List of institutions, etc., which the foreign scientists attending the 48th Indian Science Congress had occasion to visit in India.

Aligarh Muslim University, Aligarh

Indian Academy of Sciences, Banglore

Indian Institute of Science, Bangalore

Raman Research Institute, Bangalore

All-India Institute of Hygiene & Public Health, Calcutta

Bengal Immunity Research Institute, Calcutta

Bose Institute, Calcutta

Botanical Survey of India, Calcutta

Geological Survey of India, Calcutta

Institute of Biochemistry & Experimental Medicine, Calcutta

Indian Chemical Society, Calcutta

Indian Statistical Institute, Calcutta

School of Tropical Medicine, Calcutta

University College of Science & Technology, Calcutta

Zoological Survey of India, Calcutta

Punjab University, Chandigarh

Utkal University, Cuttack

Himalayan Mountaineering Institute, Darjeeling

Natural History Museum, Darjeeling

Delhi Polytechnic, Delhi

University of Delhi, Delhi

Bengal Engineering College, Howrah

Indian Association for the Cultivation of Science, Jadavpur

Jadavpur University, Jadavpur

Rajasthan University, Jaipur

Birbal Sahni Institute of Palaeobotany, Lucknow

Central Drug Research Institute, Lucknow

King George Medical College, Lucknow

University of Lucknow, Lucknow

Engineering College, Madras

Indian Institute of Technology, Madras

Loyolla College, Madras

Medical College, Madras

University of Madras, Madras

Bhakra-Nangal Dam, Nangal

All-India Institute of Medical Sciences, New Delhi

Central Road Research Institute, New Delhi

Central Water & Power Commission (Water Wing), New Delhi

Indian International Centre, New Delhi

Lady Hardinge Medical College, New Delhi

National Physical Laboratory, New Delhi

Patel Chest Institute, Delhi

University Grants Commission, New Delhi

Banaras Hindu University, Varanasi

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STATEMENT OF ACCOUNTS

(APPENDICES C, D, E AND F)

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APPENDIX

INDIAN SCIENCE CONGRESS

64, DILKHUSA STREET,

Balance Sheet

FUND & LIABILITIES			Rs. nP
General Fund :			
As per last Accounts ...		39,764·35	
Less Excess of Expenditure over Income	1,051·25		
Transfer to Depreciation Fund :			
For Depreciation upto last year ...	13,592·46		
For Depreciation during the year ...	2,063·90	15,656·36	16,707·61
		23,056·74	
Add Transfer from Building Fund		1,636·00	
			24,692·74
Reserve Fund :			
As per last Accounts ...		36,303·87	
Add Interest earned during the year		701·54	
		37,005·41	
Less Loss on sale of 4% Loan 1960-70	1,729·18		
Bank Charges on above sale ...	31·25	1,760·43	
			35,244·98
Building Fund :			
As per last Accounts ...		3,05,955·83	
Add Government of West Bengal Grant for Building ...	33,500·00		
Interest earned during the year	712·40	34,212·40	
		3,40,168·23	
Less Transfer to General Fund ...		1,636·00	
			3,38,532·23
Gratuity Fund :			
As per last Accounts		4,000·00	
Addition during the year		1,000·00	
			5,000·00
Depreciation Fund :			
Transfer from General Fund :			
For Depreciation upto last year ...		13,592·46	
,, Depreciation during the year ...		2,063·90	
			15,656·36
Carried Over ...			4,19,126·31

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C

ASSOCIATION

CALCUTTA—17.

as at 31st March, 1961.

PROPERTY & ASSENTS			Rs. nP
Annexure Building at cost		70,619·25	
Less Depreciation :			
Upto 31-3-60 ...	5,164·25		
During the year ...	1,636·00	6,800·25	
			63,819·00
Furniture & Fittings :			
At cost as on 31-3-60		8,370·08	
Addition during the year		853·65	
		9,223·73	
Less Depreciation :			
Upto 31-3-60 ...	5,569·71		
During the year ...	365·40	5,935·11	
			3,288·62
Typewriters :			
At cost as on 31-3-60		3,483·75	
Less Depreciation :			
Upto 31-3-60 ...	2,858·50		
During the year ...	62·50	2,921·00	
			562·75
Reserve Fund Investment :			
4% Loan 1979 (F.V. Rs. 2,000/-) ...		2,059·03	
4% 10 year T.S.D.C. of R.B.I. (F.V. Rs. 5,000/-) (As held and certified by the State Bank of India) ...		5,000·00	
State Bank of India—Fixed Deposit ...		12,532·00	
State Bank of India—Current Account ...		15,653·95	
			35,244·98
Building Fund Investments :			
3% Conversion Loan 1946 (F.V. Rs. 15,900/-) (As held and certified by the State Bank of India)		12,955·44	
State Bank of India—Current Account ...		37,941·46	
			50,896·90
Gratuity Fund Investment :			
4% 10 year T.S.D.C. of R.B.I. (F.V. Rs. 3,000/-) (As held and certified by the State Bank of India)		3,000·00	
State Bank of India—Current Account ...		1,000·00	
			4,000·00
Carried Over ...			1,57,812·25

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APPENDIX

INDIAN SCIENCE CONGRESS

64, DILKHUSA STREET,

Balance Sheet

FUND & LIABILITIES			Rs. nP
Brought Forward ...			4,19,126·31
Outstanding Liabilities :			
For Expenses	...	2,794·07	
For Foreign Scientists	(1959-60) ...	4,813·75	
,, ,, ,,	(1960-61) ...	9,756·23	
			17,364·05
Prepaid Subscription	... ...	6,149·00	
,, Admission Fee	... ...	38·00	
			6,187·00
			4,42,677·36

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C

ASSOCIATION

CALCUTTA—17.

as at 31st March, 1961.

Brought Forward ...			1,57,812·25
Depreciation Fund Investment :			
State Bank of India—Current Account ...			13,592·46
Advances :			
For Main Building	2,23,816·33		
,, Foreign Scientist	370·00		
,, General	62·41		
			2,24,248·74
Cash & Bank Balances :			
In hand (as certified)	75·00		
In current account with State Bank of India	37,867·81		
			37,942·81
Foreign Scientists Account :			
Excess of Expenditure over Income ...			9,081·10
			4,42,677·36

We report that we have audited the above Balance Sheet of the INDIAN SCIENCE CONGRESS ASSOCIATION as at 31st March, 1961, and the annexed Income & Expenditure Account and also the Statement of Expenditure on Foreign Scientists for the year ending on the same date with the books and vouchers of the Association and have obtained all the information and explanations we have required. In our opinion the Balance Sheet and the Income & Expenditure Account are properly drawn up and the Balance Sheet exhibits a true and correct view of the affairs of the Association as on that date according to the best of our information and explanations given to us and as shown by the books of the Association.

2, Church Lane, Calcutta,
Dated the 16th June, 1961.

Sd/- PAL & ROY,
Chartered Accountants.

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APPENDIX

INDIAN SCIENCE CONGRESS

64, DILKHUSA STREET,

Income & Expenditure Account for

EXPENDITURE			Rs. nP
To Establishment			30,389·87
,, Telephone Charges			797·70
,, Electric Charges			425·24
,, Travelling Expenses			19,048·40
,, Postage			12,618·28
,, Contingency			723·33
,, Charges General			430·81
,, Stationery & General Printing ...			1,574·47
,, Municipal Taxes			960·36
,, Sessional Expenses			1,779·40
,, Bank Charges			136·44
,, Air Fare for Delegation to B.A.A.S. Meeting			5,377·00
,, Contribution to Staff Provident Fund ...			1,563·91
,, Contribution to Staff Gratuity Fund ...			1,000·00
,, Subscription for journals			3,022·50
,, Postage & Stationery for Sectional Presidents			484·54
,, Audit Fee			200·00
,, Cost of Publication :			
Paper	22,817·10		
Printing	21,383·82		
Binding	4,937·25		
			49,138·17
,, Depreciation on :			
Annexe Building @ 2½% approx. ...	1,636·00		
Furniture & Fittings @ 10% approx.	365·40		
Typewriter @ 10% approx.	62·50		
			2,063·90
			1,31,734·32

2, Church Lane, Calcutta,
Dated the 16th June, 1961.

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C

ASSOCIATION

CALCUTTA—17.

the year ending 31st March, 1961.

INCOME

			Rs. nP
By Membership Subscription :			
Admission Fee	2,346·00		
Membership Subscription	55,901·44		
Sessional Membership Subscription ...	4,083·00		
Student Membership Subscription ...	880·00		
Life Membership Subscription ...	2,442·42		
			65,652·86
,, Sale of Publication			2,453·21
,, Government Grant			57,200·00
,, Grant for Delegation to B.A.A.S. Meeting			5,377·00
,, Excess of Expenditure over Income transferred to Balance Sheet ...			1,051·25
			1,31,734·32

Sd/- PAL & ROY,
Chartered Accountants.

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APPENDIX

INDIAN SCIENCE CONGRESS

64, DILKHUSA STREET,

FOREIGN SCIENTISTS'

Statement of Government Grant & Expenditure,

Rs. nP

EXPENDITURE

To Air Fare	7,250·50		
,, Rail Fare	124·62		
,, Hotel Charges	10,188·39		
,, Taxi, Transport & Sight Seeing ...	11,593·65		
,, Miscellaneous	212·35		
		29,369·51	
,, Provision for Outstanding Expenses ...		9,756·23	
			39,125·74
To Balance b/d		9,125·74	
,, Deficit Carried forward from last Accounts		23,955·36	
			33,081·10

2, Church Lane, Calcutta,
Dated the 16th June, 1961.

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C

ASSOCIATION

CALCUTTA—17.

ACCOUNT

Forty-eighth Session as at 31st March, 1961.

INCOME		Rs. nP
By Government Grant for 1960-61	...	30,000·00
,, Balance c/d	...	9,125·74
		39,125·74
By Government Grant for previous deficit	...	24,000·00
,, Balance transferred to Balance Sheet	...	9,081·10
		33,081·10

Sd/- PAL & ROY,
Chartered Accountants.

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APPENDIX

INDIAN SCIENCE CONGRESS

Revised Budget Estimate

EXPENDITURE		Rs. nP
To Establishment		33,000·00
,, Telephone		800·00
,, Postage		13,000·00
,, Electricity Charges		800·00
,, Cost of Publication :		
Paper	22,000·00	
Printing	21,000·00	
Binding	5,000·00	
		48,000·00
,, Stationery & General Printing ...		1,600·00
,, Postage & Stationery for Sectional Presidents		700·00
,, Municipal Taxes		1,500·00
,, Contingency		800·00
,, Travelling Expenses		*29,000·00
,, Sessional Expenses		3,200·00
,, Audit Fee		200·00
,, Contribution to Staff Provident Fund ...		1,700·00
,, Charges General including Bank charges		1,900·00
,, Depreciation		9,000·00
,, Contribution to Gratuity Fund ...		1,000·00
,, Provision for Purchase of Books ...		3,000·00
,, Air passage for one/two delegates attending B.A.A.S. Meeting		10,800·00
		1,60,000·00

* This includes Rs. 10,000/- earmarked for payment of travelling expenses to past General Presidents, etc., who may attend the opening ceremony in respect of the buildings of the Association.

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D

ASSOCIATION

for 1961-62.

INCOME			Rs. nP
By Membership subscription including Life Membership fees	...	...	67,000·00
,, Miscellaneous Receipts	...	...	3,000·00
,, Donation form N.I.S.I.	...	...	1,000·00
,, Government Grant	...	...	**89,000·00
			1,60,000·00

** This includes the grant of Rs. 10,800·00 nP. to be given by the Government of India for meeting the cost of air passage of two delegates to attend the B.A.A.S. Meeting.

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APPENDIX

INDIAN SCIENCE CONGRESS

64, DILKHUSA STREET,

EXPENDITURE			*Budget Estimate* Rs. nP
To Establishment ...	...	...	35,000·00
" Telephone ...	...	...	1,000·00
,, Postage ...	...	...	14,000·00
,, Electricity Charges	...	...	2,000·00
,, Cost of Publication :			
Paper ...	...	25,000·00	
Printing ...	...	23,000·00	
Binding ...	...	6,000·00	54,000·00
" Stationery & General Printing		...	3,000·00
" Postage & Stationery for Sectional Presidents ...	...	...	1,000·00
"Municipal Taxes ...	...	...	1,500·00
" Contingency ...	...	...	1,000·00
" Travelling Expenses	...	...	20,000·00
" Sessional Expenses	...	...	5,000·00
" Audit Fee ...	...	...	200·00
" Contribution to Staff Provident Fund	...	...	1,800·00
" Miscellaneous including Bank charges ...	...	...	1,500·00
" Contribution to Staff Gratuity Fund ...	...	...	1,000·00
" Depreciation ...	...	...	9,000-00
" Provision for purchase of books and journals ...		...	3,000·00
" Air passage for two delegates attending B.A.A.S. Meeting		...	11,000·00
" Expenses to implement the schemes of creation of a Professorship and bringing out two special publications to commemorate the Golden Jubilee of the Science Congress to be held in 1963		...	80,000·00
			2,45,000·00

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E

ASSOCIATION

CALCUTTA—17.

for 1962-63.

INCOME		Rs. nP
By Membership Subscription of different categories		80,000·00
" Grant from National Institute of Sciences of India		2,000·00
" Miscellaneous Receipts		3,000·00
		85,000·00
" Excess of expenditure over income to be met by Government recurring grant including Rs. 11,000/- to be given to meet the cost of air passage of two delegates for attending the B.A.A.S. Meeting and Rs. 80,000/- to be needed in connection with the Golden Jubilee as mentioned against the last item under expenditure		1,60,000·00
		2,45,000·00

N.B.—The provision of Rs. 1,500/- on account of Municipal Taxes is based on the present assessment, and it may have to be revised after the City Corporation authorities reassess the premises now that the construction of the main building and the auditorium has been completed.

The application of the Association for a total exemption from payment of Municipal taxes is still being considered by the Local Self-Government Dept., Govt. of West Bengal, and their decision is awaited.

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APPENDIX

INDIAN SCIENCE CONGRESS

64, DILKHUSA STREET,

STAFF PROVIDENT

Income & Expenditure Account for

EXPENDITURE	Rs. nP
To Balance-being surplus transferred to members accounts	266·01
	266·01

Balance Sheet

FUND & LIABILITIES

Members Account :		
Balance as per last account	16,218·84	
Add Contrtibution from Association ...	1,563·91	
Contribution by members	1,563·91	
	19,346·66	
Add Surplus from Income & Expenditure Account	266·01	
		19,612·67
		19,612·67

2, Church Lane, Calcutta—1.
Dated the 30th August, 1961.

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F

ASSOCIATION

CALCUTTA-17.

FUND

the year ending 31st March, 1961.

INCOME	Rs. nP
By Interest on loan to Members ...	17·08
" Bank interest	248·93
	266·01

Sd/- PAL & ROY,
Chartered Accountants.

as at 31st March, 1961.

PROPERTY & ASSESTS

Investments :		
State Bank of India (Savings Account) ...	10,276·59	
4% Ten-Year Treasury Savings Deposit Certificates (Face value)	9,000·00	
		19,276·59
Loan to Members :		
Granted during the year	427·00	
Less repaid during the year	108·00	
	319·00	
Add Outstanding interest	17·08	
		336·08
		19,612·67

We have audited the above Balance Sheet of Indian Science Congress Association—PROVIDENT FUND as at 31st March, 1961 and the above Income & Expenditure Account for the year ending on the same date with the books and papers of the Fund. We have obtained all the information and explanations we have required. In our opinion the Balance Sheet and the Income & Expenditure Account have been correctly drawn up according to the books and papers and according to the information and explanations as given to us.

Sd/- PAL & ROY,
Chartered Accountants.

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INDIAN SCIENCE CONGRESS ASSOCIATION

(REGISTERED UNDER ACT XXI OF 1860)

RULES

NAME

1. The name of the Society shall be the INDIAN SCIENCE CONGRESS ASSOCIATION* hereafter called the Association.

OBJECTS

(A) The objects of the Association shall be :—

(a) To advance and promote the cause of Science in India ;

(b) To hold an annual Congress at a suitable place in India ;

(c) To publish such proceedings, journals, transactions and other publications as may be considered desirable ;

(d) To secure and manage funds and endowments for the promotion of Science, including the rights of disposing of, or selling all or any portion of the properties of the Association ;

(e) To do and perform any or all other acts, matters and things as are conducive to, or incidental to, or necessary for, the above objects.

(B) Membership of the Association shall be open to all persons and organisations interested in the advancement of Science in India.

CONSTITUTION

Members and Subscriptions

2. The Association shall consist of Members, Honorary Members, Sessional Members, Student Members and Institutional Members.†

(A) A person paying an admission fee of Rupees five (Rs. 5/-) and agreeing to pay an annual subscription of Rupees twelve (Rs. 12/-) shall become a Member of the Association. The annual subscription of a member shall become due on the 1st

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* The Registered Office of the Association is situated at 64, Dilkhusa Street, Calcutta.

† Persons and Institutions coming under the category of Benefactors in terms of the old Rule No. 7 shall continue to enjoy the rights and privileges embodied in that Rule.

Old Rule No. 7:

Any person paying a lump sum of Rs. 500/- or more or any institution paying a lump sum of Rs. 1,000/- or more shall be a Benefactor of the Association, subject to the approval of the Executive Committee. Benefactors shall have all rights and privileges of Members during their lifetime.

An institutional Benefactor shall have the right to nominate one person as Member of the Association.

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February of each year. Any one who fails to pay the subscription on or before the 15th July in any year, shall lose the right of voting and/or holding any office of the Association for that year. A member failing to pay the annual subscription by the end of January following, shall cease to be a Member.

(B) Honorary Members of the Association shall be persons eminent for their contributions to Science, or persons who have rendered conspicuous service to the development and welfare of Science in India. The number of such members shall be limited to 25 of whom not more than two shall be elected in any one year. Honorary members shall be elected by the Council, by not less than two-thirds majority, on the recommendation of the Executive Committee. Such election shall be reported to the General Committee at its Annual Meeting.

(C) Sessional members shall be those who join the Association for the session only. Such members shall be of 2 categories :

(*a*) Sessional Member ... ... Subscription Rs. 15/-
(*b*) Student Member ... ... ,, Rs. 5/-

3. Compounding fee :—

(A) Any Member may compound all future annual subscriptions by the payment of a single sum of Rs. 200/- (Rupees Two hundred).

(B) Any person who has been continuously a Member for 10 years or more, shall be allowed a reduction in the compounding fee of Rs. 5/- for every year of such membership, provided always that under no circumstances the compounding fee shall be less than Rs. 50/-.

RIGHTS AND PRIVILEGES

4. A Member of the Association shall have the following rights and privileges :—

(A) To contribute papers for reading at the session of the Cogress.

(B) To receive free of charge, the usual publications issued by the Association for the Session, and other publication at a concession rate to be determined by the Executive Committee from time to time.

(C) To fill any office in the Association on being duly elected thereto.

5. An Honorary Member shall have the rights and privileges of a Member but shall not be eligible to hold any office other than that of the General President.

6. (A) A Sessional Member shall have the right to contribute papers for reading at the session of the Congress and to receive free of charge, the usual publications issued by the Association relating to the session of the Congress of which he is a member.

(B) A Student Member shall have the right to submit papers for reading at the session of the Congress, of which he is a member,

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provided such papers be communicated through a Member, Sessional Member or an Honorary Member of the Association.

(C) A Student Member shall, before admission, be duly certified by the Head of his Institution to be a bonafide student.

OFFICIAL YEAR

7. The official year of the Association shall be from the 1st February to the 31st January of the following year, but the financial year shall relate to the period from the first of April to the 31st March of the following year.

EXECUTIVE COMMITTEE

8. There shall be an Executive Committee for carrying on the administration of the Association. All important questions of policy shall be referred to the Council in the first instance, and the recommendations of the Executive Committee thereon shall be placed for consideration before the General Committee at its Annual Meeting.

9. (A) The Executive Committee shall consist of the President, the immediate Past President, the two General Secretaries, the Treasurer and ten Members elected by the General Committee. It shall also include one nominee of the Government of India, preferably from among the Members of the Association.

(B) For the purpose of election of 10 members of the Executive Committee by the General Committee, a Member or an Honorary Member may propose the name of any Member. Such proposal must, however, be seconded by another Member (or Honorary Member) and reach the Gentral Secretary at Head Quarters before the 15th of September. The Executive Committee shall scrutinise the nominations and circulate the valid names, together with such other names, not exceeding three, as it may suggest, to all Members and Honorary Members for election by ballot. The ballot paper shall be scrutinised by the President or his nominee and such of the General Secretaries as are present at the session and the result of the ballot shall be announced during the session at the Annual Meeting of the General Committee.

If any vacancy occurs in the Executive Committee after the Annual Session but before the First Statutory Meeting, such a vacancy shall be filled up by the next man in the voting list of the session. In case the vacancy occurs after the First Statutory Meeting, the Executive Committee shall fill up such vacancy in the Executive Committee by one, preferably from the list of voting stated above.

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(C) Members who have served on the Executive Committee for three successive years, shall not be eligible for election as members of the Executive Committee for a period of two years thereafter.

(D) The Executive Committee shall co-opt as its members not more than two Local Secretaries for the ensuing session of the Congress.

POWERS AND DUTIES OF THE EXECUTIVE COMMITTEE

10. The powers and duties of the Executive Committee shall be as follows :—

(A) To manage the affairs of the Association and for this purpose to frame such regulations, as may be deemed necessary, for the efficient administration of the Association ; provided always that such regulations be not inconsistent with anything contained in these Rules and that they be reported to the next meeting of the General Committee.

(B) To direct and manage the publication of the proceedings and other publications of the Association.

(C) To appoint salaried officers, clerks or servants as may be considered necessary, to fix their salaries, gratuities, honoraria and privileges, and to suspend, dismiss or dispense with their services as may be required, provided that all such actions shall be reported to the next meeting of the General Committee.

(D) To prepare and present to the General Committee at its Annual Meeting, to be held during the session of the Science Congress, the Annual Report of the working of the Association and the Audited Statement of the income and expenditure for the preceding financial year, the balance in hand, the assets and liabilities, together with the budget of the estimated income and expenditure of the ensuing financial year.

(E) To deal with all matters, not otherwise provided for in these Rules subject to these being reported to the General Committee at its Annual Metting.

MEETINGS OF THE EXECUTIVE COMMITTEE

11. (A) There shall be three Statutory Meetings of the Executive Committee—one each at Calcutta, at Delhi and at the venue of the Congress. Additional meetings, as may be necessary, may also be held. Notice of such meetings, along with the Agenda, shall be sent out at least a fortnight before the date of the meeting. Emergency meetings may, however, be convened by the General Secretaries, at the instance of the President, giving a week's notice.

(B) The ordinary method of voting shall be by show of hands, but on demand, the votes shall be taken by ballot.

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(C) The Chairman shall be entitled to vote. When votes are equal, he shall have a second or casting vote.

(D) Minutes of the Proceedings of every meeting of the Executive Committee shall be taken during its progress, by one of the General Secretaries, and in case of his absence by one of the members, whom the Chairman may appoint for the purpose. The Minutes shall afterwards be circulated to all members of the Executive Committee.

(E) Five members shall form a quorum.

GENERAL COMMITTEE

12. There shall be a General Committee consisting of all the Members and Honorary Members of the Association.

13. (A) The Annual Meeting of the General Committee shall be held during each session of the Congress. Fiftyone Members shall from the quorum for this meeting. Decisions shall ordinarily be taken by a show of hands of the majority of the Members present and voting at the meeting. Any Member may, however, demand a ballot on any question and the ballot shall be taken at the meeting. In any matter, at the requisition of 26 Members and Honorary Members, the President shall direct that a postal ballot be taken.

(B) An Emergency Meeting shall be convened to discuss any specific matter during the session of the Congress if a requisition signed by not less than 50 Members and Honorary Members be received by the General Secretary at Head Quarters a fortnight before the commencement of the Session.

COUNCIL

14. (A) There shall be a Council consisting of the members of the Executive Committee, all such Members or Honorary Members of the Association who have held Office as President, General Secretary, or Treasurer, the Sectional Presidents for the Session, seven Members of the Association elected by the General Committee, conveners or secretaries of statutory committees as may be appointed by the General Committee and one member of the Corporation of Calcutta.

(B) For the election of 7 Members to the Council, any Member or Honorary Member may propose the name of a Member. Such proposal, however, shall be seconded by another Member or Honorary Member and must reach the General Secretary at Head Quarters before the 15th of September. The Executive Committee shall scrutinise these nominations and circulate the valid names, together with such other names, not exceeding three, as it may suggest, to all Members and Honorary Members,

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for election by ballot. The ballot papers shall be scrutinised by the President or his nominee and such of the General Secretaries as are present at the session and the results of the ballot shall be announced during the session, at the Annual Meeting of the General Committee.

(C) Eleven members shall form a quorum.

(D) If any vacancy occurs in the Council after the Annual Session but before the First Statutory Meeting, such a vacancy shall be filled up by the next man in the voting list of the session. In case the vacancy occurs after the First Statutory Meeting the Executive Committee shall fill up such vacancy in the Council by one, preferably from the list of voting stated above.

(E) Members who have served on the Council for three successive years, shall not be eligible for election as members of the Council for a period of two years thereafter.

15. The Council shall be consulted by the Executive Committee on all important questions of policy or scientific consequences. In the matter of election of Office-bearers, the Council shall exercise such powers as are assigned to it, under the rules.

GENERAL PRESIDENT

16. (A) The Association shall have a General President. He shall be elected annually by the Council from among three names recommended by the members of the Executive Committee. The election shall be by postal ballot. The ballot papers shall be scrutinised by the Executive Committee at a meeting to be held prior to the meeting of the General Committee and the result shall be reported to the General Committee at its annual meeting during the session of the Congress.

(*Note* :—The General President shall assume office on the 1st of February and relinquish the same on the 31st January of the succeeding year).

(B) Powers and Duties of the General President shall be as follows :—

(*a*) To preside at all meetings of the Association, of the Council, and of the Executive Committee and to regulate the proceedings at such meetings.

(*b*) To ensure due effect being given to these Rules and to the Regulations made thereunder.

(*c*) In absence of any definite Rule or Regulation on any question likely to arise in connection with the administration of the Association or in the case of a doubt as to the interpretation of any of the Rules and Regulations, the President shall give a decision and his ruling or interpretation shall prevail for the time being.

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(*d*) He shall be an ex-officio member of all Committees and Boards appointed by the Executive Committee.

(*e*) He shall have the power of summoning through the General Secretary at the Head Quarters, a special meeting of the Executive Committee or of the Council, giving a week's notice to all members thereof.

GENTRAL SECRETARIES

17. (A) There shall be two General Secretaries from among the Members of the Association, one of whom shall be resident at the Head Quarters of the Association. They shall be elected by a postal ballot by the Council from amongst two names nominated by the Executive Committee for the office of each of the General Secretaries in accordance with the procedure laid down in the Regulations. The election shall be reported to the General Committee at its Annual Meeting, during the Session of Congress.

(B) Powers and Duties of the General Secretaries shall be as follows :—

(*a*) To conduct the affairs of the Association, in accordance with the Rules and Regulations of the Association, provided always that some of the powers and duties may be delegated, with the consent of the Executive Committee, to other members of the Executive Committee.

(*b*) To record, or cause to be recorded, the proceedings of the meetings of the Association, during their progress.

(*c*) To edit the publications of the Association with the help of a Publication Committee constituted for this purpose by the Executive Committee and to be the custodian of important documents and papers.

(*d*) To exercise general supervision over the salaried staff and all affairs of the Association and to fine or suspend any member of the salaried staff for gross negligence of duty or misconduct, subject to comfirmation by the Executive Committee.

(*e*) To delegate some of their powers and duties, by mutual agreement among themselves, to the Local Secretaries during the Annual Session of the Congress.

(*f*) To be ex-officio Members of all Committees and Boards constituted by the Executive Committee.

(*g*) To exercise supervision over exchange or sale of books and other publications of the Association and to report such sales or exchanges to the Executive Committee at the next meeting for information.

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TREASURER

18. (A) There shall be a Treasurer, elected by the Council by a postal ballot from amongst two names nominated by the Executive Committee from among the Members of the Association residing at Head Quarters. The election shall be reported to the General Committee at its Annual Meeting during the Session of the Congress.

(B) Powers and Duties of the Treasurer shall be as follows :—

(*a*) To receive and hold on behalf of, and for the use of the Association, all moneys received by the Association, to disburse all sums due from the Association and to keep accounts of all such receipts and disbursements. Disbursements exceeding Rs. 200/- shall be made only by order of the Executive Committee under the signature of the Chairman of the meeting at which the order was passed.

(*b*) To submit all accounts and vouchers of receipts and disbursements annually to the Executive Committee for examination and also to the auditors when required by them.

(*c*) To keep separate accounts of funds, if any, administered by the Association on behalf of Government or any individual or organisation.

(*d*) To be an ex-offico member of all Committees and Boards appointed by the Executive committee.

TERMS OF OFFICE OF GENERAL SECRETARIES AND TREASURER

19. The term of office of each General Secretary and of the Treasurer shall be for a period of three years, following election. A General Secretary or Treasurer shall not be eligible for re-election to the same office for a period of two years after the termination of appointment.

20. In the event of a vacancy amongst the General Secretaries and the Treasurer occurring between two sessions of the Congress, the Executive Committee shall have the power to appoint a General Secretary or the Treasurer for the period upto the termination of the next session of the Congress.

LOCAL SECRETARIES AND RECEPTION COMMITTEE

21. There shall be two or more Local Secretaries for each session of the Congress. They shall be appointed by the Executive Committee in consultation with the Organisation inviting the Congress to hold the session. Not more than two of the Local Secretaries shall be co-opted as members of the Executive Committee, as provided for in Rule 9 (D). All the Local Secretaries shall be either Members or Sessional Members of the Association

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but the two Local Secretaries co-opted on the Executive Committee, must be Members of the Association.

22. There shall be a Reception Committee for each session of the Congress. The Reception Committee shall be formed in consultation with the Executive Committee in accordance with the Regulations framed for the purpose.

SECTIONAL OFFICERS AND SECTIONAL COMMITTEES

23. (A) for the purpose of scientific deliberations during the session of the Congress, there shall be such sections, corresponding to different branches of science, as may from time to time be constituted by the General Committee on the recommendation of the Council.

(B) It shall be competent for any section, after its first day's meeting at the session, to hold its scientific meetings in sub-sections, for the purpose of dealing conveniently with different groups of papers submitted to the section. To conduct deliberations in each sub-section, a separate chairman and a reporter may be appointed by the Sectional President, in consultation with the Sectional Committee. Persons thus appointtd will not, however, be considered as Sectional Officers. In each section, there shall be the following Sectional Officers:—The President, the Recorder, and the Local Sectional Secretary.

24. The President and the Recorder shall be elected by the Sectional Committee from among the Members of the Association, in accordance with the procedure laid down in the Regulations, for the purpose. Where this procedure has not been followed, these appointments shall be made by the Executive Committee, after receiving nominations from the defaulting Sectional Committees. There shall be a Local Sectional Secretary who shall be appointed by the Executive Committee, on the recommendation of the Local Secretaries.

25. (A) The President shall be elected annually. The term of office of the Recorder shall be for a period of two years following elections.

(B) The work of each Section shall be conducted by a Sectional Committee which shall consist of the following:—

(*a*) Sectional Officers (vide Rule 23 (B)).

(*b*) All Members and Honorary Members of the Association who have been Presidents of the Section or who have served as Recorders for a full term.

(*c*) Four Members of the Association, elected annually by the Members and Honorary Members belonging to that section, in accordance with the Regulations made for the purpose.

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(C) The President and the Recorder shall be executive officers of the Section. They shall have power to act on behalf of the Sectional Committee in any matter of urgency, which can not be brought before the Sectional Committee for consideration, but they shall report such action to the Sectional Committee at its next meeting.

(D) The Sectional President shall be convener of the meetings of the Sectional Committee and shall preside over all meetings of the Committee. His ruling shall be final on all points of order that may arise.

In the absence of the President at any meeting of the Sectional Committee the senior-most past President of the Section, present at the meeting, shall take the chair. In the absence of any past President, the Sectional Committee shall elect a Chairman for its meeting.

(E) The Sectional Committee shall meet prior to the first meeting of the Section, and daily thereafter during the session, unless otherwise determined at a meeting of the Sectional Committee.

(F) The Sectional Recorder shall act as the Secretary of the Sectional Committee and shall maintain a proper record of the proceedings of the Sectional Committee and of the Section, in a book provided for the purpose. He shall be responsible for all local arrangements for the work of the Section and for arranging the Sectional Excursions, in consultation with the Local Secretaries.

SUBMISSION OF PAPERS

26. (A) All papers submitted for readering at the session of the Congress shall be forwarded to the General Secretary at Head Quarters so as to reach him not later than the 15th of September preceding the session.

(B) A paper submitted for reading at any section of the Congress shall be accompanied by an abstract in triplicate not exceeding 200 words. Abstracts, unaccompanied by complete papers, shall not be accepted.

(C) All papers submitted for reading at a session of the Congress shall be checked by the General Secretary at Head Quarters, in regard to the standing of the authors of the papers as members of the Association. Each paper together with a copy of its abstract shall then be sent by the General Secretary to the Sectional President concerned, for referring and acceptance, if found suitable. All reports of referees shall be confidential. The decision of the Sectional President regarding the acceptance of any paper shall be final.

(D) Each paper shall be accompanied by a declaration that the data and information presented therein will not have appeared in print before the conclusion of the session of the Congress at which it is to be read.

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(E) Abstracts of only the papers received by the General Secretary at the Head Quarters on or before the 15th of September, and accepted for reading at the session, shall be printed in Part III of the Proceedings. *In very exceptional circumstances,* however, abstracts of papers received after the due date may be printed in Part IV, provided that such papers have been read at the Section and the publication of their abstracts have been specially recommended by the Sectional President.

PUBLICATION OF PROCEEDINGS

27. The Proceedings of the Indian Science Congress Association shall be published in one volume, in four separate parts, as follows :—

Part I Contents :—List of Officers, Proceedings of the Inaugural meeting of the Session (Except the General Presidential Address) and all Official matters.

Part II ,, All Presidential Addresses.

Part III ,, Abstracts of papers accepted for reading at the Session, in accordance with Rule 26E.
(Note :—This part shall be distributed before the session to all Members, Honorary Members and Sessional Members of the Association).

Part IV ,, Discussions held at the session, Late Abstracts (accepted for publication in accordance with Rule 26E), List of Members of the Association and the Index.

(*Note* :—Part I to IV shall be distributed to all Members, Honorary Members and Sessional Members).

CHANGE OF RULES

28. The following procedure shall be observed for making any addition to, or alteration in, the Rules of the Association :

(A) Proposal for additions to, or alteration in, the existing Rules may be made by the Executive Committee, the council, the Members or the Honorary Members of the Association. Such proposals, along with amendments, if any and the opinions thereon, of the Executive Committee and the Council, shall be placed before the General Committee for its consideration, at its Annual Meeting, during the session of the Congress.

(B) The General Committee shall have at least one month's previous notice of the proposals made by the Executive Committee or by the Council. At least six weeks' previous notice of proposals made by Members or Honorary Members shall be given to the General Committee.

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(C) Proposals by Members or Honorary Members shall be sent to the General Secretary at Head Quarters so as to reach him at least two months before the meeting of the General Committee at which they are to be considered. The General Secretary at Head Quarters shall circulate such proposals to all Members and Honorary Members of the Association, at least six weeks before the meeting of the General Committee.

(D) Any amendments to the proposals circulated in accordance with Rules 28 (C) shall be sent by Members or Honorary Members to the General Secretary at Head Quarters so as to reach him at least a month before the meeting of the General Committee. Amendments to proposals from the Executive Committee or the Council shall reach the General Secretary at Head Quarters, at least two weeks before the meeting of the General Committee.

(E) At the meeting of the General Committee, the voting on such proposals and amendments, shall be in accordance with Rule 13 (A) and the proposals shall be accepted if not less than two-thirds of the number of members present and voting, cast their vote in favour of the proposals.

(Adopted by the General Committee at its meeting on the 5th and 6th January, 1954. Rule 25A amended by the General Committee at its meeting held on the 10th January, 1958).

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REGULATIONS

I. ELECTION OF GENERAL PRESIDENT (RULE 16A)

(1) The General Secretary at Headquarters shall invite nominations for the office of the General President of the Association by a circular letter to the members of the Executive Committee not later than the 1st August. Such circular shall include a list of the General Presidents of the past 15 years, and the branches of science in which they had specalised.

Nomination shall reach the General Secretary at Headquarters not later than 1st September.

(2) The General Secretary at Headquarters shall circulate the nominations received to the members of the Executive Committee for expression of opinion by 7th September. Such opinions shall reach the General Secretary at Headquarters not later than the 25th September.

(3) The nominations, together with the views of members thereon, shall be placed for selection of *three* names before a Statutory Meeting of the Executive Committee to be held in October.

(3a) If less than three names are available, the Executive Committee shall suggest other name or names to make the total of three names.

(4) The *three* names thus selected shall be circulated by the 15th November to the members of the Council for election of the President by postal ballot. The ballot paper shall reach the General Secretary at Headquarters not later than 15th December.

These ballot papers shall be scrutinised as the President may direct at a Statutory Meeting of the Executive Committee to be held on the day previous to the commencement of the Session of the Congress. The result of the scrutiny shall be announced by the President in the meeting.

(6) The result shall be reported to the General Committee at its Annual Meeting during the Session of the Congress.

(7) In the case of elected President expressing his inability to preside before the first Statutory Meeting of the Executive Committee, the office shall be filled by the next person on the panel. Thereafter, the Past-President or in his absence any one of the Past-Presidents will be invited by the Executive Committee to be President of the Congress for the year.

II. ELECTION OF GENERAL SECRETARIES AND TREASURER (RULES 17A & 18A)

(1) The General Secretary at Headquarters shall invite nominations for the offices of the General Secretaries and Treasurer of the Association by a circular letter to the member of the Executive Committee not later than the 1st August.

Nominations shall reach the General Secretary at Headquarters not later than 1st of September.

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(2) The General Secretary at Headquarters shall circulate the nominations received to the members of the Executive Committee for expression of opinion by 7th September. Such opinion shall reach the General Secretary at Headquarters not later than the 25th September.

(3) The nominations together with the views of members thereon shall be placed for selection of *two* names for each of the office at a Statutory Meeting of the Executive Committee to be held in October.

(3a) If less than two names are available, the Executive Committee shall suggest other name or names to make the total of two names.

(4) The *two* names thus selected shall be circulated by the 15th of November to the members of the Council for election of each of the offices by postal ballot. The ballot papers shall reach tht General Secretary at Headquarters not later than the 15th December.

(5) These ballot papers shall be scrutinised as the President may direct at a Statutory Meeting of the Executive Committee to be held on the day previous to the commencement of the Session of the Congress. The result of the scrutiny shall be announced by the President in the meeting.

(6) The election shall be reported to the General Committee at its Annual Meeting during the Session of the Congress.

(7) In the case of any vacancy in between two Sessions of the Congress, the Executive Committee shall have the power to appoint these officers for the period up to the termination of the next Session of the Congress.

III. PUBLICATION COMMITTEE

According to Rule 17B (*c*) and in order to help the General Secretary in editing the Publication of the Association a Publication Committte, consisting of one member of each of the sectional Committees of the year resident in Calcutta, preferably President or Recorder or elected member of the Sectional Committee will be constituted.

In cases of non-availability of any of the above members of any section, the senior Past-President of the section will be co-opted.

IV. FORMATION OF THE RECEPTION COMMITTEE (RULE 22)

(1) The General Secretaries and the Treasurer of the Indian Science Congress Association shall be ex-officio members of the Local Reception Committee.

(2) The Treasurer of the Indian Science Congress Association shall be an ex-officio member of the Working Committee of the Local Reception Committee.

(3) The Treasurer of the Indian Science Congress Association and a nominee of the Executive Committee shall be members of the Finance Committee of the Local Reception Committee.

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V. ELECTION OF SECTIONAL PRESIDENTS, RECORDERS, AND MEMBERS (RULES 24 AND 25)

General :

(1) Only Members of the Indian Science Congress Association are eligible for being nominated or elected as President, Recorder or Members of a Sectional Committee.

(2) Each Member of the Association may designate one Section in which he wishes to be enrolled and may designate two additional Sections in which he is interested.

Persons who do not designate the section in which they wish to be enrolled, will not be entitled to vote for the election of members of the Sectional Committees.

(3) No person shall serve concurrently in more than one Sectional Committee.

(A) *Officers* :

The President shall be elected annually, while the Recorder will hold office for two years from the date of his election.

Early in October, copies of printed form will be issued to Presidents of Sections for circulation to members of the Sectional Committee requesting them to nominate a President and a Recorder (when the office is vacant) for the ensuing meeting. Such nominations shall be accompanied by a statement of qualifications of the nominees for the office and their willingness to accept the same if elected thereto.

By the 15th of November, the President of each section shall circulate to the members of the Sectional Committee all such nominations received by him, together with brief statements of their qualifications and request them to vote by ballot one member for each office.

The election of Presidents and Recorders shall be by a simple majority of votes.

The ballot papers shall be opened at the first meeting of the Sectional Committee and scrutinised as the Chairman shall direct.

The result of voting shall be communicated to the General Secretaries, together with a complete record of the Proceedings of the Sectional Committee taken in this connection. In case a vacancy occurs after such election, the Executive Committee shall select one member, from the list of nominations received from the Sectional Committee, to fill the vacated post.

(B) *Members of the Sectional Committee* :

At the first meeting of the Section held during the session, members of the Section, and noted in the list of Members circulated present will be asked to propose the names of the persons to serve as members of the Sectional Committee during the ensuing year. In proposing names care

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should be taken to have the various branches of science included in the section and the various geographical regions represented as far as posisble.

At the second meeting of the Section, the Chairman will write the names of the proposed candidates on the black board in alphabetical order ; additional nominations at the meeting will also be permitted. Members will vote by ballot.

The four persons receiving the largest number of votes after scrutiny will be declared elected and their names communicated to the Executive Committee for announcement at the annual meeting of the General Committee. In case of a vacancy during the year, the vacancy may not be filled up, if not, otherwise specially desired by the Executive Committee.

VI. ADDRESSES OF SECTIONAL PRESIDENTS

(1) The Sectional President delivers a Presidential Address of which ordinarily the cost of printing 16 pages of the Proceedings in its usual form shall be borne by the Indian Science Congress Association and any other exceeding the limit shall bear the extra cost provided that in no case the presidential address shall exceed 25 pages. The time available for delivery of the Presidential Address shall usually not exceed 45 minutes. The manuscript of the address, ready for the press, should be received by the General Secretary on or before October 31st of the calendar year preceding the Session of the Congress at which the address will be delivered, failing which the Sectional President concerned will have to bear the full cost of printing of the address. It should be accompanied by 12 copies of a short popular summary (about 500 words) for issue to the lay press and 6 copies of a more detailed technical summary, for publication in scientific journals. The time and date of delivery of the President's Address will be communicated before the meeting of the Congress.

(2) The President shall be entitled to receive 30 copies of his address without charge, and additional copies at the cost of reprinting.

(3) Postage and stationery expenses incurred by the Sectional Presidents, will be paid by the Association on production of a certificate.

VII. PROCEDURE FOR COLLECTION OF PAPERS FOR THE SECTIONS

About the middle of April a number of copies of a printed circular will be forwarded to the President of each Section who may arrange to send these to workers in that branch of science with which his Section is concerned, requesting them to contribute papers for reading before the next meeting of the Congress.

The circular will contain a clause inviting such workers as are not yet Members of the Association to join as such.

In case of papers by joint authors, each author must be a Member of some category.

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VIII. APPLICATIONS FOR MEMBERSHIP

Applications for Membership will ordinarily be dealt with by the General Secretary at the Office of the Association up to the 15th December. After that date, applications for Membership will be forwarded to the Local Secretaries, who will open a separate account for sale of Membership tickets. The amount thus realised, together with unsold tickets, should be forwarded to the General Secretary immediately after the close of the Congress.

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FORTYNINTH INDIAN SCIENCE CONGRESS

CUTTACK, 1962

Congress President :—Dr. B. Mukerji, F.N.I.

PRESIDENTIAL ADDRESS

IMPACT OF LIFE SCIENCES ON MAN

I am deeply conscious of the honour you have done me in electing me to preside over the Cuttack Session of the Indian Science Congress. This honour, coming as it does when I am on the threshold of my sixties, is of great personal significance and joy to me. This is the first occasion in fortynine years of the life of the Indian Science Congress that it is meeting in Orissa, the land where Emperor Asoka realized for the first time in history that war was futile and that the spread of *Dharma* or righteousness was more important than the expansion of empires. The neighbourhood of Cuttack was once a great seat of learning and the Jaina monarch, Kharavela, had established many monasteries and hostels for monks and scholars there. For centuries afterwards, Cuttack and its environs remained a famous seat of Buddhism and streams of scholars came to study in the University, known as *Ratnagiri Mahavihara*, from Tibet and from areas in north-western India. It is also significant that some portions of the Vedas—the *Atharva Veda* in particular—are maintained as living tradition in Jajpur, as they are nowhere else in India. Ever since the Seventh Century A.D., Kalinga developed a distinctive style of sculpture and temple architecture, which have made Bhubaneshwar, Konarak and Puri household words wherever Indian art is admired. This great tradition and spirit of original expression in art, literature and culture were maintained till very recent times by an unbroken chain of scholars and artists, little known to the outside world except perhaps, the astronomer, Chandrasekhar Samanta Roy and the artist, Giridhari Mahapatra. In an atmosphere pervaded with such glorious culture, tradition and lore, I have every hope that the scientists assembled here today will be able to deliberate effectively on science, its achievements and its impact on society.

The choice of a subject for a General President's address is not easy. In his Presidential Address to the British Association for the Advancement of Science over sixty years ago, Sir William Crookes remarked that while formerly the President 'unrolled to the meeting a panorama of the year's progress in physical and biological science, now he usually restricted himself to speculations connected with his own work or dealt with questions which for the time being were uppermost'. No scientist is bold enough today to attempt a review of the tremendous progress the world has witnessed during the last year in the physical and biological sciences. If a General President restricts himself to a critical analysis of his own contributions in a limited and specialised field, he is not likely to do justice to a gathering of this type in which at least thirteen different scientific disciplines with their sub-disciplines are represented. I have,

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therefore, attempted somewhat of a compromise in this Address keeping both these objectives in mind.

During the last three decades, it has been my privilege to be actively associated with the development of drug research in India. Initially in the role of a junior investigator and latterly as the leader of a team of workers drawn from different disciplines engaged in the common task of either exploring the efficacy of ancient India remedies or developing new ones, for the countless maladies afflicting the human body and mind, I am aware of the great complexity of many of the problems confronting the investigator in this field and have become more and more impressed with the necessity for utilizing methodologies of diverse sciences in finding solutions for them. Drug Research, I might add, lies in the borderland of physical and biological sciences and provides an exciting challenge for interdisciplinary contacts and coordination.

The scope of drug research is extensive ; it covers all the efforts directed towards the understanding of disease processes and the manner in which they can be combated by drugs. Besides investigations on pathological changes initiated by diseased conditions, it includes also studies on normal physiological processes in so far as they are affected by various stress syndromes or disease. Many lacunae exist in our knowledge concerning even the so-called normal activities of the human body, and obviously these should be clarified before attempting any valid scientific appraisal of drug action. The development of a drug for a specific disorder has to be necessarily preceded by investigations on the causative factors with particular reference to the nature of microorganisms invading the system, the pathological changes resulting therefrom and their impact on the bodily equilibrium not only in the patient, but also in experimental animals in which the disease process can be reproduced and followed at the level of the organ, the tissue, the cell and the sub-cellular structure. The tools and experimental techniques of several interdependent sciences have to be judiciously employed for a meaningful pursuit of this objective. Inter-disciplinary collaboration has been the most characteristic feature of drug research, indeed of research in life sciences today, and such collaboration has proved most fruitful.

Life-Sciences versus Non-Life Sciences

Life in all its unbelievable complexity and fantastic variety is undoubtedly the highest stage in the development of matter on earth and is distinguished by features of a new kind, quite foreign to non-living matter. Metabolism, heredity with its own specialized mechanism of transmission of biological patterns, the power of adaptation to internal environment (homeostasis) and to surrounding conditions, the purposeful reactivity to external stimuli, intelligence and finally, memory, thought and creative activity of man—all these are the exclusive properties of life, determined by prolonged evolution of matter under specific conditions. It is important for our future that man should try to gain a deep and sound knowledge about life and its laws, of the living nature surrounding himself, with which he shall always be inseperably connected.

I should, therefore, like to discuss this afternoon some of the recent advances in life sciences which include all the branches of Biology in its broad fundamental and applied aspects and the fields of study covered

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by Medical Sciences, and their impact on man. I make no apology for choosing this rather ambitious subject for my address and for venturing to unfold my ideas before the distinguished gathering of mathematicians, physicists, engineers, technologists, statisticians, chemists, agricultural scientists, biologists and medical research workers assembled here. Today, there is a much wider appreciation of the impact of 'non-life' or physical sciences and technology on contemporary human life than of life sciences. The progress in life sciences, though no less significant, has, however, failed to elicit sufficient attention. This is due, perhaps, to the fact that the practical benefits arising out of the large-scale application of knowledge of the biological sciences for betterment of mankind have become so interwoven with our daily lives that we almost take them for granted. A space capsule circling every ninety minutes round the orbit of the earth is, to the popular mind, more awe-inspiring than the unravelling of the exceptional complexity of the macro-molecular systems, — the essential basis of living matter — the ultra-structure of the human gene, the extraordinary architecture of a virus particle, the histochemical make-up of the end-plate in a peripheral nerve and the intricate pathways criss-crossing between the cortical nerve cells and the 'centrencephatic centre' (Penfield and Jasper, 1954). But these latter are just as important, if not more, for unravelling the mysteries of life processes.

While marvelling at the stupendous achievement of contemporary science and technology, let us not ignore the amazing advances made by Life Sciences which have helped to create an understanding of the nature of the cell and of the vital processes that are incessantly taking place in it. Even at the risk of sounding partisan, I venture to submit that in the end, history may record that the most important scientific discoveries of the decade of the Hydrogen Bomb, the Sputniks and the Thor missiles were not of the Physical Sciences, but of Bio-sciences. The contradiction between the vast potentialities of nuclear energy for human welfare (when properly used) and its extreme destructiveness (when misused) have brought us today face to face with the social implications of science and technology. The knowledge stemming from investigations into the molecular basis of life and heredity is likewise fraught with both pleasant and dangerous consequences ; and we owe it to humanity to assess these developments and harness them exclusively for human welfare and happiness.

Meeting Ground of All Disciplines

Life Sciences have today taken tremendous strides and it has become almost impossible to present a comprehensive or unified picture of the progress achieved in the last decade or two. One feature, however, stands out, namely, the evolution of biology from the descriptive, codifying and cataloguing phase of a century ago to the present phase of analysis and measurement. While the biologist of yesterday fought shy of measurements, today he regards measurement as the very essence of his work ; he is not content with merely recording changes of forms and functions ; his studies go beyond to the very basic molecular patterns of dynamic life structures. This change of face is reflected in the ever-increasing multitude of instruments and appliances employed by the biologist ; even obstruse mathematical concepts are pressed into use. And this adoption of the tools of physical science has led to phenomenal developments. Far more effective than this has been the active participation of the chemist

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and the physicist in investigations of biological problems. It may be said without exaggeration that Life Sciences have literally come of age with the purposeful collaboration of biologists and medical men with chemists, technologists, physicists and mathematicians.

The far reaching developments ushered by this joint and coordinated effort may be illustrated by the remarkable work on deoxyribonucleic acid (DNA) which functions as the carrier of heredity and has come to be known as the 'agent of destiny' residing in the nucleus. DNA has a molecular weight of about 10 million and it has been shown that this helical molecule is composed of 10,000 purine-pyrimidine pairs. The sequence of arrangement of so many base pairs would naturally give rise to the possibility for the formation of almost an infinite number of permutations and combinations, which would account for so many species and varieties which occur in the living world. The structure of DNA was first proposed by the physicists, Watson and Crick, and confirmed by Wilkins and Franklin by X-ray analysis. The crowning achievement was its synthesis by the biochemist, Kornberg, using his brew of enzymes and substrates. No less exciting is the painstaking and masterly work of Sanger on the chemistry of insulin which, besides revealing the active site of insulin action, laid the foundation for studies on peptide structure and amino acid sequence in proteins. Recent studies by duVigneaud and colleagues on peptide hormones (Corticotrophin, melanotrophic hormone, hypertensin, oxytocin, vasopressin, etc.) from the tissues of different animal species also indicate that different topochemical changes in molecular structure have quite different effects on biological activity of a particular substance.

A visit to a modern laboratory devoted to research in brain physiology, for instance, would be revealing. The digital computer, the electronic stimulator, the implantation electrodes, the electro-encephalograph, and the electronic pulse generator have become indispensable counterparts of the conventional kymograph, the respirometer and the Gieger-Muller counter. Refined tools have become necessary for attacking problems of organization, differentiation and function at the molecular level, and the methodology and techniques of the biochemist, the biophysicist, the pharmacologist, and the biometrician are utilized in abundant measure to gain an insight into the nature of the neuron, the biochemical changes at the end-plates in nerve-fibres by which the nerve impulse is conducted, and how the totality of sensory experience, apparent to us as memory, is stored. This is but one example of the coordination of diverse experimental approaches for the study of problems pertaining to an isolated aspect of life sciences. Often the combination of a variety of specialist techniques has become indispensable for achieving success in such investigations.

Form and Function

It may be rewarding to survey briefly the advancing frontiers of life sciences with a view to obtain an assessment of the current state of development. Classical biology has concerned itself mainly with *form* and *function* and their interdependence. The most significant change in this field has been the extension of the earlier concepts of morphology and physiology from the level of the organism as a whole (or of discrete organs) to the dimensions of the cell and its sub-units. Thus, conventional histological

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staining, though it is still valuable, has become more meaningful with the introduction of histochemical techniques. The reproduction of a diseased condition in an experimental animal, important as it is for the study of its chemical pathology, is now being extended to the study of the isolated diseased organ and to cells grown in tissue culture.

The cell in its place has yielded to micromanipulation and fragmentation techniques of lysis, homogenisation, centrifugation, and partitioning in artificial media. Microinjectors now used in the dissections of cells can measure and control fluid volumes of less than one-fifty millionth of a drop and the hooks, scalpels, needles, scissors, etc. used in microsurgery have comparable micro-characteristics. By a combination of these highly precise mechanical devices it is now possible to isolate discrete anatomical units from the cell ; for example, from the nuclear material of mammalian liver cell, one can separate the nucleoli, spindle-fibres, nuclei, the mitochondria and the microsomal ribonucleoprotein particles, and these isolated sub-units can mediate specific functions, such as oxidative metabolism or biosynthesis of proteins. Studies on transplantations of nuclear material have special bearing on genetic processes. If transplanted so that it becomes part of the nuclear complex of a host cell, the nucleolus, for example, serves as a genetic marker that can be followed in the successive generations of the altered cell. Transplantations of portions of chromosomes or of nucleolar organizers also offer precise ways of studying gene action and cell differentiation processes. An intelligent comprehension of such fundamental physiological phenomena as electron transport or trapping of energy as Adenosine triphosphate (ATP) or permeation of metabolites across membrane structures is now possible by a reconstitution of subcellular units torn apart from the living cell. The main point that emerges from these studies is that any specified physiological function is the outcome of a well-defined and almost predetermined arrangement of component units in the spatial geometry of the cell. The slightest alteration of this arrangement, brought about either by unknown congenital factors or by artificial means, for example, injury, drugs, disease or exposure to radiations, leads to untoward disturbances in the overall activity of the collective system.

Molecular Biology

Advances in our knowledge of macromolecules, particularly proteins, nucleic acids and mucopolysaccharides, have been rightly heralded as the dawn of a new era in Biology. Biology has now assumed a new dimension, and a new branch of study, namely, Molecular Biology has emerged. Scientists from diverse disciplines have joined hands in developing this new science. It must be emphasised that studies in molecular biology are more a matter of tools and techniques than of the experimental material. For example, it is immaterial today whether one works with bacterial cells or with tumour or brain cells in order to obtain an insight into the molecular basis of life. Tissue culture and chemostat have made it possible to control environmental factors at will, and to keep a single line of cells going through endless cycles of growth and multiplication in synthetic media composed of comparatively simple substances. Bacterial and fungal auxotrophs may be used in investigations on the laws of inheritance and geneticists have found the technique highly rewarding. Developments in biochemical genetics have been so rapid that we can hope to understand, in the near future, the process by which characters like

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fermentability of a sugar or resistance to an antibiotic, are transmitted from the mother cell to the daughter cell in terms of nucleotides and their arrangement in the chromosomal DNA structure. Employing a variety of mammalian cells from liver, kidney, bone marrow or brain, the replication of single lines of viruses can be followed and a rational approach to the chemotherapy of virus infections is being developed.

Techniques do not make a science, just as tools do not make a man. Nonetheless, it must be admitted that the newer techniques of molecular biology are revolutionising our approach to problems like cancer, heart diseases, and brain disorders, solutions for which can be found only through a better understanding of the normal processes of cell division or of the building up of macromolecular structures. Thus, a cancer cell does not apparently differ from an ordinary cell and yet it has the capacity of multiplying at a rate nearly thousand times faster than the ordinary cell. An aerobic pathogen exhibits nearly all the metabolic characters of a host cell, and yet due to some subtle difference, the pathogen is enabled to find its habitation in the host tissue and elaborate toxins. The eventual aim of Molecular Biology is to find where and why these subtle differences exist. Today we know that the activity of an enzyme protein is associated with a specific arrangement of amino acids in the polypeptide chain. We also know that the alignment of nucleotides in the DNA has much to do with the process of transmission of characters through reproduction. Perhaps the mystery of the cancer cell rests in its peculiar DNA structure, driving the cell machinery to a mad frenzy of activity devoid of self-restraint which characterises the normal cell. The translation of knowledge gleaned from DNA and protein structures to the understanding of the memory process or of mental derangement in terms of the sequential arrangement of amino acids in the receptor protein and the nucleotide structure of neuron RNA or DNA is no longer a wild dream, but a distinct possibility in the near future.

The Cell—Primary Unit of Life

Within the body, the cells behave like small organisms plunged in an aerated and nutritive medium. All living cells depend absolutely on the medium in which they are immersed ; they modify this medium unceasingly and are modified by it. Despite its minuteness, each cell is a very complex organism, as it is now possible to see with the aid of newer techniques of electron-microscopy. It reveals a new world of minute structures within its wall.

One of the marvels of cellular biology is the toti-potential cell, the ovum. The nature of forces bound within the membrane of this single cell, so small as to be invisible to the naked eye, that leads to specialized development of parts and their organization to make so complex a structure as man, is perhaps the greatest mystery of life. To think that within a simple, quite undifferentiated single cell there is contained the pattern and the means to build along this pattern, not merely eyes, but blue and brown eyes—not merely hair, but hair that is red or black or yellow—straight or curly or kinky—hair that will begin to 'fall out' at a relatively early age or hair that will retain its lustre late in life or hair that will become 'prematurely' dry and grey. The same applies to colour of the human skin in different racial groups in the world including their sensitiveness to different types of light and heat radiations and develop-

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ment of patchy areas of hyper- and de—pigmentation at different periods of life. These things are determinable at this one-cell stage as surely as is the four-chambered character of the heart—the number and distribution of acid-secreting cells in the stomach—the distribution of nerve cells and their interconnections so that precise sensory and motor functions can be carried out—so that we can think—so that we can have aspirations and hopes—and so that we may have a conscience as well as consciousness. And finally, so that we may produce cells which have all the potentialities of the cell from which we ourselves came.

Today, molecular biology is focussing our attention on the structure and organisation of the cell as the basic unit—not just in health but in disease too. We are looking at cytoplasmic constituents and at parts of nuclei, and are getting interested in mitochondria and chromosomes. Just as within the atoms in physical matter, there lies a whole new world of structure, so it is with the components of the living cell. Not only structure but a force of infinite importance similar to atomic energy lies dormant inside the simple cellular components—a force which is not wild and uncontrolled but permits reproduction of the ovum again and again and again. What mysterious forces control its growth? What is it that causes this reproduction to stop at the precise moment when the organism is complete? Why does not this growth continue to make giants of us all—microbes, mammoths—mice and men alike?

Cellular Organization and Differentiation

The mechanism by which a mass of cells organize themselves into the outer shapes so familiar to us in the form of our functional units of organs such as the liver lobule, the nephron, etc. is still obscure. Since form is the outward expression of the morphogenic process that has shaped it, a study of the developmental processes of different organs and tissues leads us to some understanding of the levels of organisations in our body. 'Embryonic development' says Weiss, 'is an intricate assembly-line process in which the original material endowment of the egg is progressively transformed by chains of different and complicated interactions proceeding according to a definite inherited production schedule. This schedule has become so blue-printed by evolutionary experience that, given a standard range of enviromental conditions (climate, nutrition, stress, etc.) it will lead to viable and reproductive individuals capable of passing on that pattern and schedule to successive generations'. The deviations from this general phenomenon are due to either some major initial flaw in the genic equipment or some disruptive stress factor introduced from outside such as malnutrition or infection.

What can be considered as one of the most fascinating biological experiments of recent times is the work of Weiss and his colleagues at the Rockefeller Institute, New York, on the behaviour of multi-cellular systems in tissue culture. Suspensions of single cells of kidney and cartilage cultured in the appropriate nutrient medium yield large blocks of kidney tissue clearly demarcated against large blocks of cartilage tissue. This is apparently the first *in vitro* demonstration of the independent organization of two distinctively different types of cells into conglomerant tissues outside the animal body. Using the elegant technique of time-lapse cinematography under the phase contrast microscope, the behaviour and orientation of a mixture of epithelial cells of liver, kidney, lung, skin and

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eye could be followed to trace the sequence of events that happen when two cells of the like kind or unlike kind are brought together. Free single cells move around by sending out broad 'mobile tongues' of protoplasm along the glass surface to which they cling normally. There is no attraction or repulsion between individuals till they actually touch each other and remain in close physical contact sufficiently long to recognize each other. Then they pull together and remain closely associated if they are of the same kind ; if not, they break away from each other till they meet cells of their own kind. By this proces of trial and error, mixed populations of cells sort themselves out into large groups consisting of purely single cells of one kind or the other. In this process of sorting out, tissue specificity appears to be more dominant than species specificitv as exemplified by the fact that liver cells of a mouse link very well with liver cells of a chick, but liver cells and kidney cells of a chick repell each other.

The discriminatory behaviour of cells described above poses a number of questions : What is the mechanism by which a cell recognizes its own kind (or class) in a mixed population (or society) ? Is there any specific attraction or repulsion centres on cell surface reminiscent of the behaviour of serological reaction which are equally specific ? How do strange pairs of cells brought close to one another under compulsion, part company ? Is this reaction immutable ? Can this response be dulled or sharpened and if so, by what means ? Is the property of metastasis of cancer cells, by virtue of which they migrate from their site of origin and habitate inhospitable areas in host tissues, a result of a loss of this power of discrimination ? What is it that happens in parasitism which renders the host cell subservient to the metabolic demands of the parasite ?

Physiology of the Organ and the Organism

Finding answers to this formidable array of questions will undoubtedly keep investigators in the fields of life sciences busy for many years to come. The complexity of the problem increases as we move from the uni-cellular and multi-cellular level of thinking towards the understanding of 'Organ' physiology or the phenomena which enable groups of cells to work together as in a society to perform a particular function, e.g., the heart, blood and blood vessels constituting the circulatory system, the brain, spinal cord, and peripheral nerves, constituting the nervous system, etc. etc.

(a) *Heart and Circulatory System*

The human heart is one of the most amazing creations of nature, infinitely more efficient than any man-made machine. It beats at a steady tempo more than 100,000 times a day, 36 million times a year, more than 2·5 billion times in the course of a lifetime of three score and ten. It is a muscle, a living pump, about the size of a man's fist weighing about three-quarters of a pound, which in a 24-hour period performs work equal to the lifting of one ton 50 feet into the air. Every day it pumps 4,320 gallons of blood through 60,000 miles of blood vessels, a distance equal to two-and-a-half times the earth's circumference, supplying oxygen and nourishment to some 300 trillion cells in the average human body. Yet it is active only one-third of the time, resting between beats about two-thirds of the time. This is possible because of the finely tuned cardio-vasculatory regulation of the human body. If all the vascular beds of

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the body were to open simultaneously to their full capacities, the total peripheral resistance would disappear and the cardiac output would be swallowed up, leaving no trace of an arterial pressure. In order, therefore, to permit the circulatory pumps and vessels to carry out their proper functions, most of the blood vessels of the body must be partially or even severely constricted a great deal of the time. To accomplish this, vasoconstriction must be balanced neatly against vasodilatation, with both attuned to cardiac output and to tissue needs.

'The control of the degree of dilatation of the blood vessels is achieved primarily by the interplay of peripheral mechanisms. These include the effects of metabolic vasodilators, produced by muscles and other working tissues, which act directly or through axon reflexes. These local mechanisms are supplemented by a system of efferent vasodilator nerves transmitting messages from the central nervous system. When these vasodilator influences are unchecked, a state of vascular collapse and shock may ensue. Against these tendencies, a group of powerful vasoconstrictor mechanisms is available and in constant function. Their role is to reduce unnecessary blood supply to tissues. This vasoconstriction is guided by an hierarchy whereby certain favored organs insure their own blood supply, particularly the brain, the heart and the kidney.' The control of the degree and sites of vasoconstriction, depends predominantly on the action of the central nervous system and the influence of hormonal action including the permisive effects of steroids and other substances.

The normal human heart is such a sturdy organ that it hardly ever 'fails' as is commonly reported, and could keep on contracting and relaxing at the same tempo for an estimated hundred years. But the stresses and strains of modern living are resulting in changes, in the internal chemical environment in which the heart pulsates, which lead to damage of the arteries feeding the heart and to the impairment of its functioning. As a result, diseases of the heart and of the blood vessels including coronary arteries have greatly increased during recent times until they have become the greatest cause of death in all modern industrialized societies.

(b) *Brain and Nervous System*

Man's brain, which has transformed the world and has discovered the power to destroy it, is perhaps the greatest enigma in modern science. It took at least a billion years of evolution to create the 3-pound mass, which only in the last century has begun to acquire a dim understanding of its own nature. During the last twenty years, there have been significant new advances in our knowledge of the brain, as a result of modern neurophysiological and neuropsychopharmacological research, accompanied by refinements in electronics, instrumentation techniques (Electroencephalograph) and radioactive tracers. Brain surgery and modern electroablation and cauterization techniques are further enriching our knowledge of many hitherto obscure brain functions and its behaviour in certain types of mental aberrations. Indeed, there is a tantalizing prospect that research now under way will finally shed light on how the nervous system operates and perhaps explain what is 'mind' and what are the connecting links between man's brain and the thoughts in his head.

It is yet too early to present a complete picture of the complicated processes involved. It seems clear now that the neurons (nerve cells) that perform the 'highest level of integration' are to be found not in the

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brain's outer layer, or cortex—as has hitherto been supposed—but deep within the brain, in the so-called reticular system, a region that is among the most ancient from the standpoint of evolution. Recognizing that the brain is being continuously bombarded, even during sleep, with sensory impulses, the problem for science has been to discover how the brain filters out meaningful stimuli, assigns priorities among stimuli competing for attention (ignoring them all, if sufficiently fatigued), and finally makes a decision to do just one thing at a time, out of the near-infinity of possible things to do.

According to the new hypothesis, all this is achieved by a complex interchange of nerve impulses—bearing coded information—between cortical neurons and neurons in the reticular system. One task of the cortex, evidently is to assign meanings to incoming stimuli—notably to things seen, heard, smelt, tasted, and touched and to store these meanings, in some fashion, for future reference. The cortex also, it seems, transmits some sort of condensed, edited and annotated version of the flood of incoming sense stimuli into the reticular system, where the final integrating process takes place. This final integration may lead the reticular system to issue impulses that will 'arouse' appropriate sensorimotor regions of the cortex to initiate a type of muscular response that has proved successful under similar circumstances in the past—or, alternately, it may call upon some part of the brain (Probably the cortex) to give more 'thought' to the problem. It is perhaps too early to say whether this short account of the role of the reticular system is correct or mistaken. If correct, it goes far toward explaining the unity of the central stream of consciousness. Even so, however, it sheds virtually no light on such equally basic problems as : what, really, takes place in learning ; what is memory ; and what is intelligence and what is 'learning to unlearn' (Gerard, 1961).

Up-to-date techniques are further making it possible to observe what goes on inside the living brain, man's most complex organ and in a sense his most vulnerable one. How does it all work? What happens when something goes wrong in this socalled control centre of our thoughts, emotions and actions? Much light has recently been thrown by mental health workers and psycho-pharmacologists through the study of simple behaviour patterns in the individual and in selected groups, on the nature of intelligence, on how the brain learns, finds its satisfactions, and why, on occasion, it breaks down. It is now posible to indicate that epileptic seizures and schizophrenia—a form of madness—are primarily neuro-physiological and biochemical in origin—traceable, perhaps, to a disturbance in an enzyme system or to a harmful chemical compound substituting for a needed one—or whether the ailment is basically a malfunction in information processing peculiar to computers containing billions of switching components. There is ample cogent evidence to show that breakdowns in mental health can be improved by psycho-pharmacologic agents. 'Drugs for the mind' are now available which will calm manic excitement, will alleviate severe depression, will control convulsions and so on. The 'psychic energizers' or antidepressants act in a manner reverse to that of tranquielizers by deactivating an enzyme known as monoamineoxidase (MAO). The monoamineoxidase inhibitors (Iproniazid and similar drugs) have provided during recent times, an important new tool in the study of cerebral metabolism, and possibly also towards additional knowledge of the biochemistry of emotion and other forms of mental illness. To understand the brain with its 10 billion nerve cells working at any one

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instant, it will first be necessary to know more than is now known about neurobiochemistry and neuro-pharmacology (including the role of hormones), biophysics, the advanced mathematics of large random ensembles, and the new science of 'information theory.'

The Science of Man

A highly developed organism like the human being is not a mere assembly of discrete cells, tissues, organs and organ systems but an *organism* capable of manifesting physico-chemical, physiological and psychological activities. Man represents an integrated personality in whom all the individual activities are controlled, integrated, and coordinated by a central guiding principle. When the individual tissue breaks loose from this bond of loyalty to the common good, we have the socalled abnormal manifestation of disease. The human system has often been compared to a machine composed of intricate components. This comparison is useful as an operational concept to analyse certain functions of the body in detachment from the whole, as for example, feeding to fuelling, digestion to combustion, working of the heart to the action of a pump, etc. There the analogy stops and as we move on to organization and coordination of activities, the human system exhibits a level of complexity not attainable by any man-made machine.

The more we study man in his entirety, the more deeply we analyse his structure and physiological functions, the more impressed we are with the ancient Biblical saying that 'man is wonderfully made'. There is no method capable of apprehending him simultaneously in his entirety, his parts, his relations with the outer world and his reactions thereto. There is intimate coordination between each functioning part and the whole in a manner which beggars description. Even as I am standing before you delivering my Address, I am energised with electrochemical impulses, most of them quite well mediated and directional leading to some purposeful end result. Proprioceptive impulses are traversing sensory pathways from my muscles and tendons, up and across specific spinal and cerebellar pathways, and after central mediation (with all that it implies), these are modified and co-ordinated and returned through efferent spinal tracts to effector organs and muscles and other tissues, thus permitting me to remain in some semblance of balance. The effect of space and position upon the semicircular canals of the inner ear, as well as the effects of light upon the rods and cones of the retina with their specific and respective pathways through the eighth and second cranial nerves add to the complicated picture of maintaining this sense of balance. Simultaneously, my autonomic nervous system, controlled by set reflex patterns, is regulating all my vegetative body processes and helping me to maintain homeostasis through the release of autopharmacologic monoamine substances such as adrenaline, noradrenaline, histamine, acetylcholine, serotonin, kallikrein and bradykinin. However, the superimposition of the brain with its autonomic capacities, but under potential influence by higher and finely integrated cerebral processes, may affect psychosomatically those end organs under the control of the autonomic nervous system, either for better or for worse. The headache and the neurogenic rise of blood pressure that I am having at the moment are convincing me forcefully that the 'psyche' has powerful control over the 'soma'.

All the activities of our body on ultimate analysis, are the result of the linking, to the triumvirate axis of the pituitary, the adrenals and the

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gonads, of the electrochemical impulses generated in the central nervous system by the various stimuli on our sensory organs of perception. The manner in which this coordination is effected resulting in such remarkable precision and integration has hitherto baffled our comprehension. Endocrine physiology and biochemistry have opened up vistas of investigation on the action mechanism of the powerful hormones secreted by these neuro-endocrine glands. From the plethora of experimental evidence available we have just begun to learn that behaviourism, temperamental responses to external stimuli, etc. reflect very closely the interaction of these hormonal activities with the directive function of the nerves.

Man and his environment

Every living thing depends intimately on its surroundings and adapts itself to any modification of these surroundings by an appropriate change. Man is no exception to this general rule but his adaptation mechanism is very much more intricate and comprehensive than is found even in the highest developed animal life.

(a) Hypothermia

Man is a warm-blooded animal and is therefore forced to maintain his body temperature under differing climatic conditions of extreme heat and extreme cold. How far the physiological adaptive mechanisms are capable of withstanding extreme degrees of hypothermia or cooling has been recently studied with many startling new results. By 1948 it seemed firmly established that adult non-hibernating mammals would not withstand cooling to internal body temperatures below a level characteristic for each species and between 25°C (78°F) in the dog and 15°C (59°F) in the rat. This was because breathing and heart beats ceased and were not resumed when the animals were rewarmed. Observations on cases of accidental exposure and the results of Nazi experiments on prisoners of war in concentration camps suggested that 25°C (77°F) was the lethal body temperature in man.

In 1950, Bigelow and his cowrokers in Toronto published a series of papers on the oxygen consumption of dogs at reduced body temperatures and on the factors involved in their survival. The brain is particularly sensitive to oxygen lack at normal body temperatures and its circulation cannot be arrested for more than three minutes without irreparable damage due to deprivation of oxygen. At deep body temperatures of 20°C, however, the oxygen requirements of the brain and other tissues are greatly reduced and the dog heart can actually be excluded from the circulation for 15 minutes without injury. Bigelow suggested that the use of hypothermia would permit intracardiac operations for otherwise incurable diseases of man and might also extend the scope of surgery on other organs.

(b) What is death?

An even more remarkable observation was recorded in Belgrade in 1951 by Andjus. He found that 20 per cent of intact adult rats could be fully revived after cooling the surface of the body in ice until the internal body temperature reached between 0° and 2°C and until breathing,

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heart beats and circulation had been arrested for one hour. Golden hamsters would revive after freezing for as long as one hour in baths at −5°C. The skin and subcutaneous tissues reached a temperature of −4°C and contained much ice. There were also ice crystals in the blood and around and within the vital organs including the heart and brain. The internal body temperature reachd −1°C in many hamsters which subsequently recovered completely. The surprising results from these and similar experiments have naturally raised the problem of the diagnosis and definition of 'death'. We can only say that it is the *condition from which reanimation is not possible by any currently known means.* Prof. Negovski of Moscow has studied the problem of reanimation extensively and suggests a distinction between 'clinical death' which is reversible and 'biological death' which is irreversible. One of his recent discoveries is that death from severe blood loss in dogs, monkeys and even in man can be averted by reducing the internal temperature of the body to a moderate degree (about 25°C in dogs) by cooling the surface of the body. A wide variety of mammalian cells and tissues can now be preserved for periods far exceeding their normal life span in the body by treating them with glycerol or dimethyl sulphoxide or some other protective substance and then storing them either at −79°C or else in liquid nitrogen at −190°C. The capacity to enter and remain for long periods in a state of latent life (otherwise known as anabiosis or cryptobiosis) under adverse natural conditions such as severe drought, intense heat and bitter cold may be essential for the survival of many species. This state of anabiosis might not be attainable and might not serve any useful purpose under natural or artificial conditions in man or any of the larger mammals. On the other hand, it is interesting and important to know about its occurrence in the lower animals on earth. A variety of potentially living creatures may be lying dormant on the moon or on other planets and might come to life if they were brought back to earth. Many mysteries about survival of life undoubtedly remain to be solved by those who stay earthbound.

(c) *Nature of Sleep*

A recent symposium in London led by Lord Adrian has given a fascinating review of this age-old problem. The current concept is that decreased activity in the reticular formation, resulting in sleep, is the result of inhibitory impulses passing to it from different parts of the brain. This is part of a larger concept, that the normal working of the brain is a balance between inhibitory and excitatory impulses. The former exists in the waking as well as in the sleeping state. (If this were not the case, we should all be epileptics). It is the alterations in this balance with resultant changes in the complex interactions between differnt parts of the brain, that are responsible for the many differing degrees of wakefulness and sleep. Sleep is a state of unconsciousness into which the messengers of consciousness can penetrate. Thus, there is no evidence to support the suggestion that sleep is due to accumulation in the body of some mysterious 'toxin' which acts as a narcotic and so induces sleep. Neither is there any evidence that sleep is due to temporarily diminished blood supply to the brain, or a lack of oxygen. In other words, the overall functional activity of the brain is as high in sleep as in the waking state. 'The need for sleep does not exist in the brain, but somewhere else in the body'. The brain actually 'epens up', so to speak, all of its sensory pathways during sleep.

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(d) *Ageing Process*

With the advent of modern drugs and public health measures, human mortality and morbidity have been reduced to a very large extent. Man today has a longer expectation of life and it is understandable that he would like to grow 'old' without being 'aged' and senile. Scientific investigations have proceeded in recent times at various levels including individuals and populations, organs and organ systems, tissues, cells and sub-cellular structures. There is evidence to suggest that body water declines in volume with age and there is a tendency for shrinkage of cell water and for a greater proportion of body water to be located outside the cells. The electrolytes located inside the cells tend to decrease. The hexosamine and collagen ratio of connective tissue is also found to decrease with age. Insoluble solids called 'age pigments' have been identified in cells of various tissues of aged people. Examination of the nerve cells of the guineapig has shown that the neuronal elements of the central nervous system accumulate 'lipofuchsin' with advancement of age. Carroll Williams at the Harvard University has reported isolation of a 'hormone' which suppresses metamorphosis and thus postpones maturity in insects. Similar hormone ('juvenile hormone') has been found in mammalian tissues including human placenta.

Despite the availability of a mass of valuable biological data, the organic problem involved in senility remains obscure and we do not know precisely as to what accumulates, or breaks down or fails to function or goes 'seedy' in old age. Probably the psychic component is more important in the ageing process. Gerontologists have shown that in aged people some basic changes in the behaviours and mental capacity occur in the form of low performance on tasks requiring mental manipulation and perceptual searching. This may be related to a condition of senile change of the neurons as pointed out by Soviet physiologists.

(e) *Space biology*

The problems of space flight have given us recently much new knowledge on cellular and organic adaptation of plant and animal life to very different conditions of temperature, pressure, humidity and radioactivity. Already higher forms of animal life, e.g., dogs, chimpanzees, have been sent to the orbit and brought back to earth alive in space capsules fitted with modern physiological and electronic recording devices. Based on such new informations, cosmonauts have also been sent to the orbit and returned to earth in a healthy condition. The future holds promise of much new and exciting knowledge on physiological adaptation processes under these completely different external environmental conditions for man.

Outlook for the Future

We have seen thus far that the tremendous strides made by contemporary research in the Biosciences had enabled us to gain at least a working knowledge of the fundamental mechanisms involved in a number of manifestations in the panorama of life. It is now clear that life has a firm material basis and beginning, and that the process of multiplication and heredity can be explained generally in terms of the

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macro-molecular structures of the nucleic acids and proteins. We are now in a position to look upon living creatures as beings who have evolved from simpler ancestors, who are related to their immediate progenitors and successors by inseverable bonds of heredity and who function by biochemically definable mechanisms in specific internal and external environments.

The progress of biological research on the two fronts of Neurology and Ecology has shown very clearly the closeness of the inter-relation between the neural and the psychical. Some think of mental activity and nervous activity as two inseparable aspects of one reality. A recent and significant advance in the field of this inter-connection is the discovery by Penfield and Jasper (1954) that some of the deeper parts of the central nervous system 'Centrencephalic system' have a hitherto unrecognized function in 'alerting' the brain during waking hours. This central brain-stem region together with certain parts of the thalami seem to project impulses upwards through a spongelike net of cells and fibres to the nerve cells of the cerebral cortex or surface of the brain. Similarly, signals from the cortex return to the brain stem which becomes thus additionally important as a centre controlling the neural network of the cortex.

These discoveries have paralleled our increasing knowledge concerning the action of certain chemical substances and drugs on cerebral activity. So fast has been the progress in this field that a new branch of Neuropharmacology with its intimate ally, Neurobiochemistry, has come to be established as an independent sub-discipline in Life Sciences. We know now that the activity of different groups of nerve cells can be varied in a specific manner by the 'tranquillizers' and the 'hallucinogens'. The current fashion in the study of brain behaviour is to pursue the subject by analogies to the 'information theory' developed in telecommunication research. The prospect of this type of approach coupled with biochemical investigations on the ulterior structure of brain cells can be very exciting for the future of mankind.

Refinement of our understanding of the secretory properties of certain nerve cells of the hypothalamus has shown that the precursors of the horomones of the posterior lobe of the pituitary do not presumably originate in the pituitary gland but are produced by two groups of nerve cells in the hypothalamus, from which they pass to the posterior pituitary through a bundle of nerve cells where they are absorbed into the blood vessel. Alteration in the delicate balance of these powerful hormones is a known feature in disease and it is obvious that their mechanism should be connected intimately with the central nervous system.

Convincing evidence of the power of the central nervous system over the rest of the body can be obtained even from our everyday experience. Most of our emotive response to the environment is the result of this type of imperceptible contact with experience. Thus symbols can be potent sources of stimuli. Hearing words which bring good news or bad, seeing a ghastly or pleasaont sight, smelling a good or bad odour can provide appropriate input for a variety of complex effector activity. In fact the entire phenomena of our aesthetic response to beauty whether in words, sound, lines, colour, form, movement or shape represented by the fine arts of poetry, music, dancing, painting, sculpture and architecture is in the ultimate analysis the integration of the highest neural activity. We may also here refer in passing to the fact that some of the great works of art and great advances in thought have been made under the influence

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of stress factors on the cenral nervous system of the creators. Reaction to stress may be measured in terms of achievemnt or the developement of fresh potentials and also in terms of the maintenance of the mental equilibrium. On the contrary it can also result in an upsetting of this equilibrium leading to physical and mental breakdown.

Man, an essentially social being, has to conform to a pattern of behaviour acceptable to his fellow beings. He has to derive spiritual nourishment from his various activities and experiences of his surroundings. He has, apart from his fundamental biological needs, to satisfy in some manner his emotional needs for love and creativity. It is apparent, therefore, that threats to his ability to perform his social functions and to enjoy his legitimate share of the fruits of his labour may constitute the stress that lies behind so many states of anxiety, tension, irritability and disease. Not ignoring the genetic and biochemical mechanism and at the same time fully cognizant of other causative factors of maladjustment, we must look more deeply for all the reasons of illness in our attempt to develop a concept of positive health. Only through a coordinated study in the domains of Life sciences including plant and animal biology, physiology, pharmacology, biochemistry, psychology and psychiatry can we hope to make worthwhile contributions to medical science for the benefit of man.

Conclusion

I have attempted in the course of this address to pick out certain facets of current research in biosciences which to my mind are going to profoundly affect our outlook on the future. We saw earlier that the influence of organization on function is well established at the minute level of the fertilized ovum, the phage particle, the microbial cell and the sub-cellular units like the mitochondria obtained from mammalian tissues. From what little is known about the structure and function of the human brain, it is apparent that the height of organizational complexity in evolution is reached in this organ. Upto the present time the brain has been considered as a 'black box' whose functioning is magical and not reducible to intelligible terms based on physical concepts of matter and energy. Recent advances in biochemical and biophysical techniques have, however, made it abundantly clear that the brain is an electro-chemical organ which, in many respects, behaves like any other organs of the body and yet different from them in some subtle manner.

The vital difference consists in the fact that the brain is the seat of consciousness and of our thoughts and judgments. Consciousness makes it possible for man to be aware of what passes in his own mind, his symbolic abstractions, and more, it allows him to be conscious of his own personal identity ("self-consciousness"). Apparently these unique mental attributes and thought processes are also molecular and submolecular in nature and are dependent on minute, immeasurable exchange of energy very much like any other physiological process. By devising model systems and robots (cybernetics) based on electronic computers we have just begun to probe into the material basis of perception. When the mechanism of the human brain is better understood at the molecular level, mankind would assuredly attain a new dimension. The human brain will then be able to master itself and extend its frontiers into the unknown.

Taking it for granted that in the creation of the human brain, the acme of organizational perfection has been reached, can we rest content

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with the belief that in us, the *Homo sapiens*, nature has exhausted her evolutionary run? We have indeed discovered how to make certain types of acquired characters heritable in lower organisms and also to perceptibly change behaviours in higher organisms by education and instruction. 'It seems unlikely', warns Hermann J. Muller, 'that in respect to the human faculties of the highest importance—such as the neuronal equipment conducive to integrated understanding, foresight, scrupulousness, humility, regard for others and self-sacrifice—modern cultural conditions may actually lead to a lower rate of reproduction on the part of their possessors than the rate of those with the opposite attributes'.

This is indeed a grim warning. On account of its firm material basis, the human gene is subject to the law of entropy very much like any other form of matter. Destructive mutation leading eventually to self-immolation is its inherent property. Having become painfully conscious of this, it is our bounden duty to do something about it. With the projected plans of building space stations and launching of cosmic bases, the human spirit, today, is preparing itself for the conquest of eternity as it were. As such, it will be cowardice on our part if we were to escape from the stark reality of our own genetic make-up and its tendency to disintegrate. The urgent need for the moment is to fit into a framework of practical eugenics, all the biological knowledge we have gathered over years of painful labour and to acquire a mastery over our own destiny.

If health and wealth are to be regarded as no more than pre-conditions of man's true progress, which is a balanced all round movement towards a fuller realisation of the true, the beautiful and the good, the Life Scientist of today can advance his position and maintain that there are in organic evolution great trends towards higher values. The seed for optimism in the future of mankind is contained in the fact that the growing emancipation of the human mind is the most significant event of this evolution. In the words of one of the greatest thinkers of modern times, Aurobindo, 'if there is an evolution in material nature and if it is an evolution of being with consciousness and life as its two key-terms and powers, this fullness of being, fullness of consciousness, fullness of life must be the goal of development towards which we are tending and which will manifest at an early or later stage of our destiny'.

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SECTION OF MATHEMATICS

PRESIDENT : DR. P. L. BHATNAGAR, M.Sc., D.Phil., D.Sc., F.N.I., F.A.Sc.

Presidential Address

NON-NEWTONIAN FLUIDS

1. INTRODUCTION

The flow properties of a fluid regarded as a continuum are determined by the following equations :

Continuity equation :

$$\frac{\partial \rho}{\partial t} + \frac{\partial}{\partial x_i}(\rho v_i) = 0$$

Momentum equations :

$$\rho \frac{Dv_i}{Dt} = \rho X_i + \frac{\partial T_{ij}}{\partial x_j}$$

Energy equation :

$$\rho \frac{D}{Dt}(C_v \theta) - \frac{Dp}{Dt} = \rho Q + \frac{\partial}{\partial x_i}\left(k \frac{\partial \theta}{\partial x_i}\right) + E,$$

where ρ, p, θ are the density, pressure and temperature of the fluid, $\{v_i\}$ is the velocity vector, $\{X_i\}$ is the external body force, $\{T_{ij}\}$ is the stress tensor, C_v and k are the specific heat at constant volume and the heat conductivity, Q is the rate of heat addition from external sources prescribed a *priori* and E is the rate of dissipation arising from all the internal processes such as viscosity. It is easy to show that in general

$$E = T_{ij} A_{ij},$$

where

$$A_{ij} = \left\{ \frac{\partial v_i}{\partial x_j} + \frac{\partial v_j}{\partial x_i} \right\},$$

is the rate of strain tensor so that E is known if the stress tensor $\{T_{ij}\}$ and the dependence of velocity on $\{x_i\}$ are known. The five equations of motion involve $\rho, p, \theta, \{v_i\}, \{T_{ij}\}$. In the case of a gas, p may be regarded as a known function of ρ and θ through the equation of state providing one more

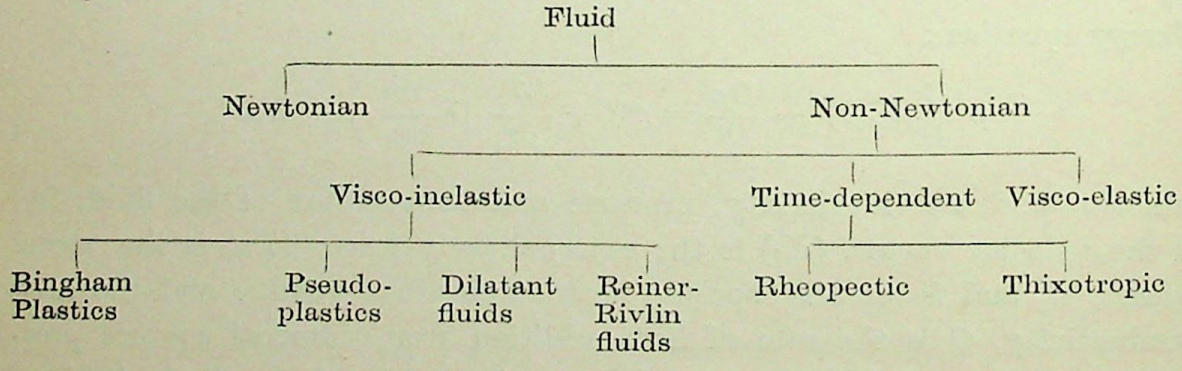
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equation to determine the six unknows, ρ, p, θ, $\{v_i\}$ if the stress tensor $\{T_{ij}\}$ can be expressed in terms of $\{x_i\}$, t, ρ, p, θ and $\{v_i\}$ so that the expression for T_{ij} does not involve new unknowns.

In the case of an incompressible fluid ρ is constant, suppressing the number of unknowns to five, to be determined by the equations of motion provided again the stress tensor can be expressed in terms of $\{x_i\}$, t, p, θ and $\{v_i\}$. Thus for any further progress in the study of the flow properties of a fluid we must specify the relationship between the stress tensor and the other properties of the flow, which are determinable with the help of the above equations of motion. It is clear that this specification has to be made from considerations which are outside the framework of fluid mechanics. Consequently one has to rely either on some mathematical models about the structure of the fluid capable of predicting something definite about this relationship or on experiments which investigate how a fluid behaves when subjected to externally imposed stresses. Both of these approaches have been adopted with considerable success.

In nature we come across fluids which show varied types of response to an applied shearing stress. As a matter of fact, we can use the nature of response of a fluid to applied stresses to effect at least a rough classification of the entire class of fluids as given below, the sub-classes being not entirely mutually exclusive, in fact in some cases overlapping each other in respect of some special properties.



Newtonian and Non-Newtonian fluids :

The simplest type of behaviour is characterised by a linear relationship between the stress and the rate of strain tensors :

$$T = \mu A. \qquad \ldots \quad (1.1)$$

All fluids obeying (1.1) are called *Newtonian fluids* and the proportionality factor μ is called the fluid viscosity which in general is a function of the material properties like temperature and pressure. The fluids which do not conform to (1.1) are called non-Newtonian. The Newtonian fluids have been extensively investigated both theoretically and experimentally.

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The interest in the non-Newtonian fluids is rather recent, but the important technological applications of these fluids which comprise macro-molecular materials, colloids, plastics, high polymers and so on, have given a considerable impetus to their study. We shall in the present address confiine ourselves to the brief discussion of some of the important flow properties of this class of fluids. Apart from the importance which this class of fluids bears in technology, the main consideration in choosing this topic has been that some workers in our country have devoted their attention to this subject and have achieved some important results. It is with pleasure that I refer to some of these results during the course of this address.

The class of non-Newtonian fluids can be further sub-divided into three sub-classes :

(i) visco-inelastic fluids (ii) Time-dependent fluids (iii) visco-elastic fluids.

(i) *Visco-inelastic fluids* are Stokesian fluids characterised by the fact that they are isotropic and homogeneous when at rest, and when they are subjected to a shear, the resultant stress depends only on the rate of shear. Inspite of this common feature this sub-class shows diverse behaviour in response to applied stress as shown in Fig. 1. From this consideration

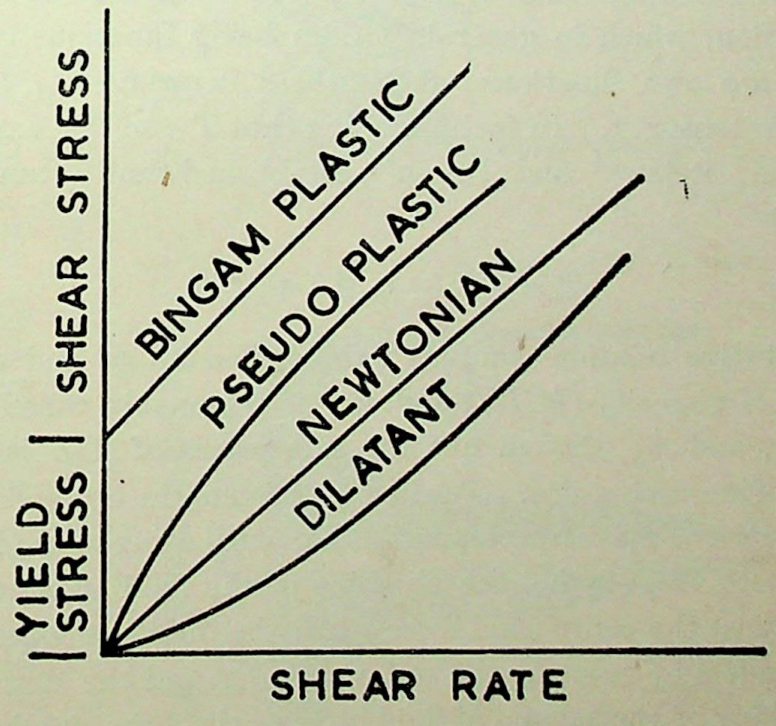


FIG. 1. FLOW CURVES FOR VISCO INELASTIC FLUIDS

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it is usual to divide visco-inelastic fluids into the following four categories : (a) *Bingham plastics* obey the Newtonian $T-A$ relation (1.1) but differ from the Newtonian fluid in sustaining a certain finite stress, called the "yield-stress" before the flow begins. (b) *Pseudo-plastic* and (c) *Dilatant fluids* exhibit the most common type of non-Newtonian behaviour, namely they obey a non-linear relationship between T and A; for example in a two dimensional simple shearing motion

$$T_{xy} = \mu^{\frac{1}{n}} \left(\frac{du}{dy}\right)^{\frac{1}{n}} \quad \text{(Ostwald's Law[27])}, \qquad \ldots \quad (1.2)$$

which may be interpreted as (1.1) provided we replace the coefficient of viscosity μ by $\mu^{\frac{1}{n}} (\Pi_A)^{\frac{1-n}{2n}}$, where Π_A is the second invariant of A. The main difference between the pseudo-plastic and dilatant fluids is that in the former category of fluids the apparent viscosity (the viscosity measured by a viscometer) decreases with the increase of rate of shear, while the reverse holds for the latter. It is important to note that in the constitutive equation (1.2), only one viscosity coefficient enters. The values of $n < 1$ ensure dilatancy, while the values of $n > 1$ attribute to the fluid pseudo-plasticity. (d) *Reiner-Rivlin fluids* are also characterised by a non-linear relationship between T and A but now more than one viscosity coefficients enter into the constitutive equation, which in general, besides being functions of the material properties, are also functions of the three invariants I_A, Π_A, III_A of the rate of strain tensor A. In fact assuming that T can be expressed in the powers of A, Reiner[33] and Rivlin[34] established that T can be completely expressed as

$$T = -pI + \Phi_1 A + \Phi_3 A^2. \qquad \ldots \quad (1.3)$$

This constitutive relation contains two coefficients Φ_1 and Φ_3. Φ_1 has the dimensions of viscosity (M/LT) and can be reasonably called the coefficient of viscosity, and Φ_3, though has the dimensions of M/L, is still called the coefficient of cross-viscosity. The introduction of the cross-viscosity term in the constitutive equation is responsible for attributing to the fluid the Weissenberg effect[45] (Fig. 2) i.e. the climbing of the fluid along the inner fixed cylinder against the centrifugal force when the fluid is sheared between two coaxial cylinders by rotating the outer cylinder and the Merrington effect[22] i.e. the swelling of the stream of fluid at the exit of the circular pipe through which it has been flowing.

(ii) *Time-dependent fluids* : Time-dependent fluids, when subjected to a steady rate of shear under isothermal conditions, show either increase or decrease in the viscosity as time passes. The fluids which show an

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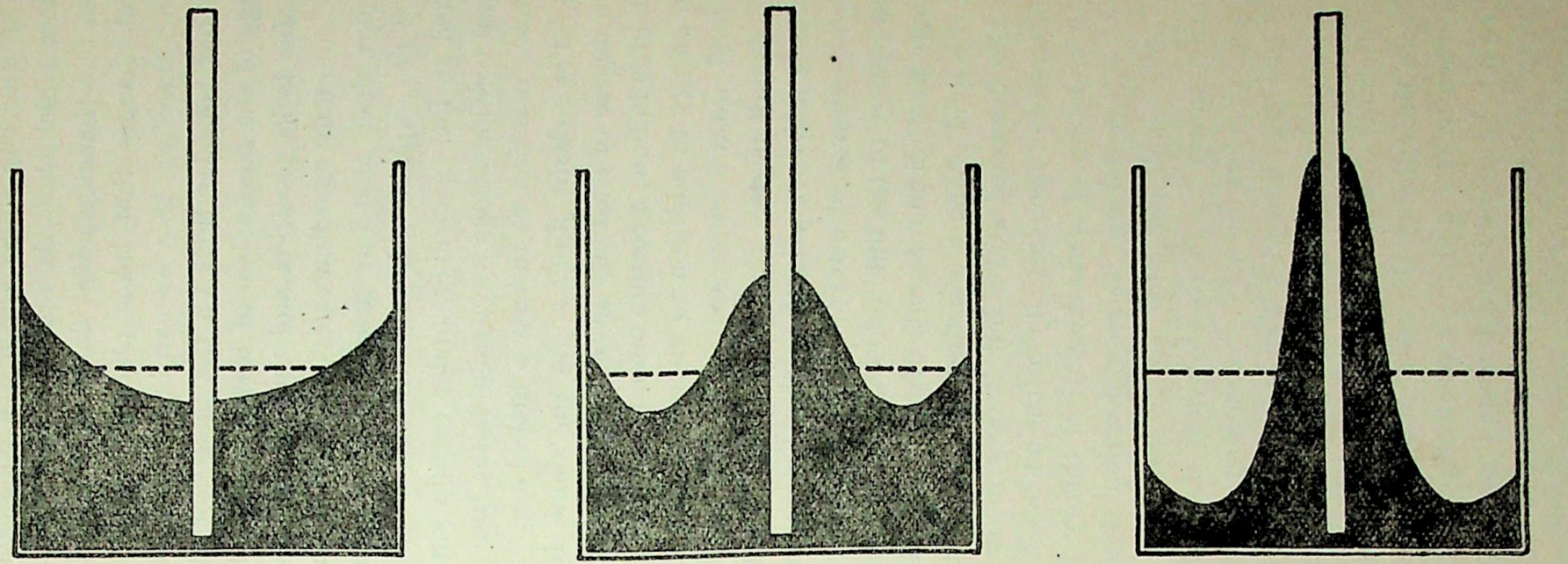


FIG. 2. INNER CYLINDER IS FIXED AND THE OUTER CYLINDER IS ROTATED

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increase in viscosity under the above conditions are called "Rheopectic", while those which show the opposite effect are called "Thixotropic". This behaviour of a time-dependent fluid is attributed to the whole sequence of structural changes that takes place following an impressed disturbance. It is clear, therefore, that we can build up a theory of these fluids only if we base our considerations on the molecular structure. At present our knowledge of the mechanism of breaking and of reformation of the molecular chains lacks precision and the accurate mathematical representation involves so many coordinates even to define the shape and orientation of a molecular chain that any general discussion becomes hopelessly complicated. This explains why no definite constitutive equation could be established so far. However, under certain simplifying assumptions some theoretical considerations are available for time-dependent materials which I shall have occasion to discuss a little later.

(iii) *Visco-elastic fluids* : As the name implies, these fluids possess a certain degree of elasticity in addition to viscosity. Thus, when a visco-elastic fluid is in flow, a certain amount of energy is stored up in the material as strain energy in addition to viscous dissipation. In a normal (inelastic) viscous fluid we are concerned only with the rate-of-strain but in elastic fluids we cannot neglect the strain, however small it may be, as it is responsible for the recovery to the original state and for the reverse flow that follows the removal of stress. These material strains are determined by the stress history of the fluid and cannot be specified kinematically in terms of the large over-all movements of the fluid. During the flow the natural state of the fluid changes constantly and tries to attain the instantaneous state of the deformed state, but it does never succeed completely. This lag is a measure of the elasticity or the so-called "memory" of the material. In the formulation of a mathematical theory an account of this memory is taken by introducing "stress-relaxation times" and "strain-retardation times". We shall call any theory based on these considerations as a "Relaxation theory". In elastic solids the natural state does not change and there is a perfect memory. A number of workers like Lodge[19], Fromm[8], Loring,[20] Dewitt[5], Oldroyd[25], Yamamoto[46] and Sagawa[47], Pao[28] have adopted this attitude in developing a mathematical theory for visco-elastic fluids.

An alternate approach to this class of fluids is due to Rivlin and Ericksen.[36,37] In their theory the material is assumed to be isotropic and homogeneous when at rest and the stress components at any instant can be expressed as a polynomial in the tensors formed by the various order material derivatives of velocity . The coefficients of various terms have to be functions of the invariants of the tensors in addition to the material properties in order to preserve their forms under translation and rotation. It is clear that in this approach we assume the end result namely the constitutive

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equation and then work backwards to trace the effect of the previous history of the fluid. This approach has an advantage, namely the theory of visco-inelastic fluids can be deduced as a particular case of this theory.

2. Various Theories

We shall now discuss in the briefest outline some of the important theories advanced to explain the flow behaviour of different classes of non-Newtonian fluids.

(A) *Rivlin-Ericksen Theory* : We shall first take the Rivlin-Ericksen theory as it happens to be the most general theory advanced so far from purely phenomenological considerations. This theory introduces the concept of memory or elasticity of the fluid through the tensor B formed by the gradient of acceleration $\{a_i\}$ namely,

$$B = \left\{ \frac{\partial a_i}{\partial x_j} + \frac{\partial a_j}{\partial x_i} + 2 \frac{\partial v_m}{\partial x_i} \frac{\partial v_m}{\partial x_j} \right\}, \qquad \ldots \quad (2.1)$$

and non-linearity through the powers and products of A and B. In fact, to start with, it assumes a polynomial for the stress tensor T in 3×3 symmetric matrices A and B, with coefficients as functions of the traces of the various tensors occurring in this representation to conform with the requirements of invariance under translation and rotation. By the repeated application of the Cayley-Hamilton theorem for a 3×3 symmetric matrix X :

$$X^3 - (\text{tr } X)X^2 + \tfrac{1}{2}[(\text{tr } X)^2 - \text{tr} X^2]X - \\ - [\tfrac{1}{3} \text{ tr } X^3 - \tfrac{1}{2} \text{ tr } X \text{ tr } X^2 + \tfrac{1}{6}(\text{tr } X)^3] \, \mathrm{I} = 0, \qquad \ldots \quad (2.2)$$

we can express any power of A or B higher than the second in terms of a quadratic expression in A or B. In order to be able to express the terms like ABA, BAB, $A^2BA + ABA^2$, ... , in terms of products of powers of A and B of extension two (where by extension of the product $A^{\alpha_1} B^{\beta_1} A^{\alpha_2} B^{\beta_2} \ldots A^{\alpha n} B^{\beta n}$ we mean the number of non-zero indices in $\alpha_1, \beta_1, \alpha_2, \beta_2, \ldots \alpha_n, \beta_n$) we use the extension of the Cayley-Hamilton theorem for 3 symmetric matrices A, B, C, of order 3 :

$$ABC + CBA + BAC + CAB + ACB + BCA \\ = (\text{tr } A)(BC + CB) + (\text{tr } B)(CA + AC) + (\text{tr } C)(AB + BA) \\ + [(\text{tr } BC) - (\text{tr } B)(\text{tr } C)]A + [(\text{tr } CA) - (\text{tr } C)(\text{tr } A)]B \\ + [(\text{tr} AB) - (\text{tr } A)(\text{tr } B)]C + [(\text{tr } A)(\text{tr } B)(\text{tr } C) - (\text{tr } A)(\text{tr } BC) \\ - (\text{tr } B)(\text{tr } CA) - (\text{tr } C)(\text{tr } AB) + (\text{tr } ABC) + (\text{tr} CBA)]I. \qquad \ldots \quad (2.3)$$

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Thus it is possible to express this general polynomial expression for T in the following form in which there is no term of extension higher than two :

$$T = \Phi_0 I + \Phi_1 A + \Phi_2 B + \Phi_3 A^2 + \Phi_4 B^2 + \Phi_5 (AB + BA) + \Phi_6 (A^2 B + BA^2) + \Phi_7 (AB^2 + B^2 A) + \Phi_8 (A^2 B^2 + B^2 A^2). \quad \ldots \quad (2.4)$$

In a straight-forward manner it is possible to show that the coefficients Φ_i can also be expressed as functions of the traces of A, B, A^2, B^2, A^3, AB, A^2B, AB^2 and A^2B^2 only.

Particular cases : We shall now record two important particular cases of (2.4).

(a) *Reiner-Rivlin visco-inelastic fluids* :

When the fluid is inelastic , $B = 0$ and the constitutive equation (2.4) reduces to

$$T = \Phi_0 I + \Phi_1 A + \Phi_3 A^2. \quad \ldots \quad (2.5)$$

(b) *Ostwald's pseudo-plastic and dilatant fluids* :

These fluids being inelastic $B = 0$, and if we choose $\Phi_0 = -p$, $\Phi_1 = \mu^{\frac{1}{n}} \Pi^{\frac{1-n}{2n}}$, $\Phi_3 = 0$, we get the generalization of Ostwald's law by Tomita.[44]

(B) *Relaxation Theory* :

As a first step, some investigations about the fluids with elasticity were based on constitutive equations involving only one relaxation time. But such a constitutive equation failed to explain the important observation about these fluids, namely the decrease in apparent viscosity with the increase in shear rate. Lodge[19], impressed by the success which the Relaxation spectrum theory met in explaining the behaviour of solid polymers, applied similar considerations to the visco-elastic fluids on the specific understanding that the deformations in a fluid in flow cannot be considered as small. This theory met with only partial success in as much as it could predict qualitatively the Weissenberg and Merrington effects but failed to explain the decrease of apparent viscosity with an increasing shear rate. It is significant to note that any theory that retains quadratic terms in rate of strain tensor in the constitutive equation, like the Reiner-Rivlin theory, is able to predict these normal stress effects. Recently, Pao[28] has made an attempt to build a physical theory using the concept of the Relaxation time spectrum for the stress components and the Retardation time spectrum for the material strains, where the time-dependent recoverable stress at a point is defined with respect to the instantaneous axes fixed in the fluid element surrounding that point. This definition of the material strain makes it independent of the overall motion of the fluid element so that even

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when it is undergoing considerable translational and rotational motion we can take these elastic deformations as small consistent with the properties of a fluid. This is one of the basic arguments in the development of the theory.

Let the Cartesian Z-frame be fixed in space, while the Cartesian Y-frame be fixed in the element at the point $P : \{z_i\}$ so that it is convected with the particle velocity $\bar{v} = \{\dot{z}_i\}$ and rotated with the angular velocity $\bar{\omega} = \text{curl } \bar{v}$. Since the fluid element at P is at rest in the Y-frame, the fluid relations are valid in this frame only. For example, the fluid element will be isotropic in the Y-frame only. Further, if the fluid element undergoes a deformation during translation and rotation and then another small deformation (recoverable elastic deformation) in the new convected and rotated position, though the second deformation is isotropic, the total response to the sum of the two deformations is not isotropic.

Denoting the tensor components in the Y-frame by subscripts a, b and in the Z-frame by i, j, we shall first derive stress-relaxation time spectrum. The distortion ϵ_{ab} of a fluid element is composed of two parts : (*i*) $(\epsilon_{ab})_v$ arising from the viscosity and (ii) $(\epsilon_{ab})_R$ owing to the delayed elastic response. Hence

$$\frac{d}{dt}\epsilon_{ab} = \frac{d}{dt}(\epsilon_{ab})_v + \frac{d}{dt}(\epsilon_{ab})_R. \qquad \ldots \quad (2.6)$$

We now assume a linear law between stress and rate of strain for viscous deformation :

$$T_{ab} + p\delta_{ab} = \eta \frac{d}{dt}(\epsilon_{ab})_v, \qquad \ldots \quad (2.7)$$

and a linear law between stress and elastic deformation as pointed out earlier :

$$T_{ab} + p\delta_{ab} = \mu(\epsilon_{ab})_R, \qquad \ldots \quad (2.8)$$

where η and μ are respectively the coefficients of viscosity and modulus of rigidity. Hence the total rate of strain is given by

$$\frac{d}{dt}\epsilon_{ab} = \frac{1}{\eta}(T_{ab} + p\delta_{ab}) + \frac{1}{\mu}\frac{d}{dt}(T_{ab} + p\delta_{ab}). \qquad \ldots \quad (2.9)$$

Now if we assume that at time $t = \xi$, the fluid element is subjected to a strain $(\epsilon_{ab})_\xi$ which remains constant in time, then we have the following equation determining the relaxation of stress

$$\tau\frac{d}{dt}(T_{ab} + p\delta_{ab}) + (T_{ab} + p\delta_{ab}) = 0, \quad \tau = \frac{\eta}{\mu}, \qquad \ldots \quad (2.10)$$

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from which we get the relaxed value of the stress at t as

$$\frac{\eta}{\tau}.(\epsilon_{ab})_\xi \exp\left(-\frac{t-\xi}{\tau}\right).$$

Hence the total stress at time t due to the constant strain $\frac{d}{d\xi}(\epsilon_{ab})d\xi$ applied during time intervals $(\xi, \xi + d\xi)$ prior and upto t is given by

$$(T_{ab} + p\delta_{ab})_t = \int_0^t \frac{\eta}{\tau} \exp\left(-\frac{t-\xi}{\tau}\right) \frac{d}{\xi d}(\epsilon_{ab})d\xi. \quad \ldots \quad (2.11)$$

If now the system possesses a number of recovery mechanisms and hence a number of relaxation times $\tau_1, \tau_2, \ldots$, we have

$$(T_{ab} + p\delta_{ab})_t = \int_0^t \sum_i \frac{\eta_i}{\tau_i} \exp\left(-\frac{t-\xi}{\tau_i}\right) \frac{d}{d\xi}(\epsilon_{ab})d\xi, \quad \ldots \quad (2.12)$$

which is the desired relaxation-time spectrum for the stress. If we regard the viscosity of a Maxwell element as a continuous function of its relaxation time, we can derive a continuous relaxation-time spectrum for stress :

$$(T_{ab} + p\delta_{ab})_t = \int_0^t d\xi \int_0^\infty \frac{\eta(\tau)}{\tau} \exp\left(-\frac{t-\xi}{\tau}\right) \frac{d}{d\xi}(\epsilon_{ab})d\tau, \quad \ldots \quad (2.13)$$

where now $\eta d\tau$ denotes the viscosity of all the Maxwell elements which have relaxation time between τ and $\tau + d\tau$.

Using similar arguments, we can show that the discrete and continuous retardation spectra for the rate of strain are given by

$$\frac{d}{dt}(\epsilon_{ab}) = \int_0^t \sum_i \frac{1}{\eta_i} \exp\left(-\frac{t-\xi}{\tau_i}\right) \frac{d}{d\xi}(T_{ab} + p\delta_{ab})d\xi$$

$$+ (T_{ab} + p\delta_{ab})_t \left(\sum_i \frac{1}{\eta_i}\right) \quad \ldots \quad (2.14)$$

and

$$\frac{d}{dt}(\epsilon_{ab}) = \int_0^t d\xi \int_0^\infty \frac{d\tau}{\eta(\tau)} \exp\left(-\frac{t-\xi}{\tau}\right) \frac{d}{d\xi}(T_{ab} + p\delta_{ab})$$

$$+ (T_{ab} + p\delta_{ab}) \int_0^\infty \frac{d\tau}{\eta}. \quad \ldots \quad (2.15)$$

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We have to make some important comments. First, the usual expression for the rate of strain will hold in the fixed Z-frame i.e.

$$e_{ij} = \frac{\partial \epsilon_{ij}}{\partial t} = \tfrac{1}{2}\left(\frac{\partial v_i}{\partial z_j} + \frac{\partial v_j}{\partial z_i}\right), \qquad \ldots \quad (2.16)$$

and hence if we wish to work in the Z-frame we must use the usual transformation relations :

$$\left.\begin{aligned} \epsilon_{ab} &= \epsilon_{ij} \frac{\partial z_i}{\partial y_a} \frac{\partial z_j}{\partial y_b}, \\ T_{ab} &= T_{ij} \frac{\partial z_i}{\partial y_a} \frac{\partial z_j}{\partial y_b}, \end{aligned}\right\} \qquad \ldots \quad (2.17)$$

and

$$\frac{d}{dt}\epsilon_{ab} = \underbrace{\frac{\partial}{\partial t}\epsilon_{ab}}_{\text{local time rate}} + \underbrace{\frac{\partial \epsilon_{ab}}{\partial \phi_i}\frac{d\phi_i}{dt}}_{\text{change due to rotating axes of reference}} + \underbrace{\frac{\partial \epsilon_{ab}}{\partial z_k}\frac{dz_k}{dt}}_{\text{change due to the convection of axes of reference}},$$

$$= \frac{\partial z_i}{\partial y_a}\frac{\partial z_j}{\partial y_b}\left[\frac{\partial}{\partial t} + \frac{dz_k}{dt}\frac{\partial}{\partial z_k}\right](\epsilon_{ij})_{\text{Total}} + \left(\epsilon_{ij}\right)_R \frac{\partial}{\partial \phi_i}\left(\frac{\partial x_i}{\partial y_a} + \frac{\partial x_j}{\partial y_b}\right), \qquad \ldots \quad (2.18)$$

where $$\frac{d\phi_i}{dt} = \frac{1}{2}\left(\frac{\partial v_k}{\partial x_j} - \frac{\partial v_j}{\partial x_k}\right)$$

are the components of the angular velocity of the fluid element at the point under consideration and ϕ_i, the angles which the instantaneous axis of rotation at this point makes with fixed axes in the Z-frame.

Secondly, these spectra can be utilized for studying the specific flow problems if we know *a priori* the dependence of viscosity on the time of re-relaxation of a Maxwell element.

(C) *Oldroyd's fluid* :[26]

As far back as 1929, Jeffreys[16] had proposed

$$(T_{ab}+p\delta_{ab}) + \tau_1 \frac{d}{dt}(T_{ab}+p\delta_{ab}) = 2\eta\left(e_{ij} + \tau_2 \frac{d}{dt} e_{ij}\right) \qquad \ldots \quad (2.19)$$

with $$\epsilon_{ij} = \tfrac{1}{2}\left(\frac{\partial v_i}{\partial x_j} + \frac{\partial v_j}{\partial x_i}\right)$$

as the constitutive equation to explain the behaviour of the visco-elastic fluids for small rates of strain e_{ij}. This equation involves three constants : a coefficient of viscosity η, a stress-relaxation time τ_1 and a rate-of-strain-retardation time $\tau_2 (< \tau_1)$.

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Recently, Oldroyd[26] has suggested many generalizations of Jeffrey's linear theory. His simplest generalization

$$T'_{ik} + \tau_1 \frac{D}{Dt} T'_{ik} + \mu_0 T'_{jj} e_{ik} - \mu_1 (T'_{ij} e_{jk} + T'_{jk} e_{ij}) + \nu_1 T'_{jl} e_{jl} \delta_{ik}$$

$$= 2\eta \left(e_{ik} + \tau_2 \frac{D}{Dt} e_{ik} - 2\mu_2 e_{ij} e_{jk} + \nu_2 e_{jl} e_{jl} \delta_{ik} \right) \quad \ldots \quad (2.20)$$

where

$$T'_{ik} = T_{ik} + p\delta_{ik}$$

and

$$\frac{D}{Dt} b_{ij} = \frac{\partial}{\partial t} b_{ij} + v_k \frac{\partial b_{ij}}{\partial x_k} + \omega_{ik} b_{kj} + \omega_{jk} b_{ki}$$

with $$w_{ij} = \frac{\partial v_i}{\partial x_j} - \frac{\partial v_j}{\partial x_i}$$ (vorticity tensor)

denotes the material derivative of ij component of a tensor which takes account of the translational and rotational motion of the material element. Constitutive relation (2.20) contains five additional constants μ_0, μ_1, μ_2, ν_1 and ν_2 which are all of dimensions of time.

The motivation of the generalization is apparent. The memory of the fluid has been taken into account through the stress-relaxation time τ_1 and the rate-of-strain-retardation time τ_2 as in a Relaxation theory and the linearity of the Newtonian constitutive equation has been broken by introducing quadratic terms in the rate of strain components and the products of stress and rate of strain components in a limited manner. Here again, the characteristic times introduced in this formulation have to be determined by simple subsidiary experiments before we can study any specific flow problems.

(D) *Molecular Model* :

We shall now describe a molecular model of a hysteric material by Green and Tobolsky[9] which takes account of the molecular changes that occur in a body as a whole during the processes of deformation which involve relaxation. We shall assume that no permanent changes occur in the body so that at any instant the internal relaxations are so adjusted that the rate of breaking of the bonds which constitute the network chains is equal to the rate of reforming. It is evident that in presenting this account, we have to take a number of results as granted. We consider a molecule consisting of N atoms connected by $N-1$ chain links each of length l_0 with angle α between two consecutive links. Though it is a drastic assumption, we shall, for the sake of simplicity, denote the gross shape of the molecule by the distance r between the two ends of a chain, as for the complete

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specification of the shape of a molecule and of the orientation of different atoms in it, we shall require $3N-3$ coordinates, introducing unsurmountable complications. Following Mark and Guth[11] and Kuhn,[18] we assume that the probability W that the distance between the two ends of a molecular chain is r, is given by*

$$W(n, l_0, \alpha, r) = \exp\ [\alpha_n - \beta_n^2 r^2] \qquad \ldots \quad (2.21)$$

where n denotes the number of bonds which permit rotation (total number of bonds minus the double bonds),

$$\left.\begin{aligned} \beta_n{}^2 &= \frac{3}{2nl_\alpha{}^2}\,, \\ \exp\ \alpha_n &= 3\left(\frac{6}{\pi}\right)^{\frac{1}{2}} \frac{1}{l_\alpha{}^2 n^{3/2}}\,, \\ \text{and} \qquad l_\alpha{}^2 &= l_0{}^2 \frac{1+\cos\alpha}{1-\cos\alpha}\,. \end{aligned}\right\} \qquad \ldots \quad (2.22)$$

We shall also assume that according to the kinetic theory of elasticity, the stress T, at any time t, will depend on the whole history of strain and in particular on the number of chains s_i formed at time t_i when the strain were l_i or σ_i and also on the final strain l or σ. Assuming that the reforming chains are in the relaxed state in order to explain the independence to the extension of the decay of stress at constant extension, the total stress at time t is given by

$$\frac{T}{Ck\theta} = \sum_i s_i \left(\frac{l^2}{l_i{}^2} - \frac{l_i}{l}\right), \qquad \text{(tension)}$$

$$\simeq \sum_i s_i \left(\frac{l-l_i}{l_i}\right) \qquad \text{(as in the case of ordinary tension)} \qquad \ldots \quad (2.23)$$

$$\frac{T}{Ck\theta} = \sum_i s_i(\sigma-\sigma_i) \qquad \text{(shear)}, \qquad \ldots \quad (2.24)$$

where the summation extends over times t_i, k is the Boltzman constant, and θ is the absolute temperature,

and

$$C = \frac{2}{3}\ \frac{1}{s_0}\ \sum_l s_l \beta_l^2 (r_l^2).$$

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* For the proof of tbis formula reference may be made to Kuhn. [18]

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We now introduce the stress-relaxation time through the following considerations. The actual rate of decay of stress depends on the rate of breaking of the chains. Evidently, this rate at any time t will be proportional to the number of chains present in the sample so that we assume

$$\frac{ds}{dt} = -k's. \qquad \ldots \quad (2.25)$$

As an approximation we shall assume k' to be a constant. This assumption has the support of experimental evidence. This on integration gives the number s of chains which out of s_0 chains at time $t = 0$ remain unbroken upto time t as

$$s = s_0 e^{-k't}.$$

Assuming stress T at time t to be proportional to the number s of chains present at time t and actually taking the stress, we can show that the change dT in stress in time interval dt is given by

$$dT = -k'T\,dt,$$

so that the stress relaxation equation is given by

$$T = T_0 e^{-k't}.$$

We can now easily introduce time in the stress formulae (2.23) and (2.24) by taking the stress history prior to instant t into account :

$$\frac{T}{Ck\theta} = \int_o^t s_0 k' \exp\left[-k'(t-t')\right]\left[\frac{l^2(t)}{l^2(t')} - \frac{l(t')}{l(t)}\right]dt' + X_0 \qquad \ldots \quad (2.26)$$

and

$$\frac{T}{Ck\theta} = \int_o^t s_0 k' \exp[-k'(t-t')][\sigma(t)-\sigma(t')]dt' + Y_0, \qquad \ldots \quad (2.27)$$

where X_0, Y_0 are the contributions of the chains that were at $t = 0$ and which remained unbroken upto time t. We get the following expressions for them from (2.23) and (2.24), on summing for t_i from $-\infty$ to 0,

$$\left.\begin{aligned} X_0 &= s_0 e^{-k't}\left(\frac{l^2}{m_0^2} - \frac{n_0}{l}\right), \\ Y_0 &= s_0 e^{-k't}\ (\sigma(t)-\sigma_{e0}), \end{aligned}\right\} \qquad \ldots \quad (2.28)$$

where

$$\frac{s_0}{m_0^2} = \sum_i \frac{s_i}{l_i^2} \ ; \ s_0 n_0 = \sum_i s_i l_i \ ; \ s_0 \sigma_{e0} = \sum_i s_i \sigma_i \qquad \ldots \quad (2.29)$$

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and the factor $e^{-k't}$ has been introduced as the probability that a chain present at $t = 0$ remains unbroken during the interval $(0, t)$.

The equations (2.26) and (2.27) with (2.28) and (2.29) give the expressions for stress in tension and in shear respectively.

Retaining the terms upto t' in the expansions of $l(t')$ and $\sigma(t')$ in powers of t' and performing the integrations, we have, if we neglect the time-dependent parts in the integrated expressions,

$$\frac{T}{Ck\theta s_0} = \frac{3}{k'} \frac{1}{l} \frac{dl}{dt} \qquad \text{(Tension)}$$

and

$$\frac{T}{Ck\theta s_0} = \frac{1}{k'} \frac{d\sigma}{dt} \qquad \text{(Shear)}$$

giving the viscosity law for tension

$$\eta = \frac{2}{k'} k\theta \sum_i s_i \beta_i^2 r_i^2 ,$$

and the rigidity law

$$\mu = \frac{2}{3k'} k\theta \sum_i s_i \beta_i^2 r_i^2 .$$

These formulae bring out the role of temperature θ, relaxation time $1/k'$, and the molecular picture in shaping the physical properties, like viscosity and elasticity of the material.

3. Some problems of non-Newtonian flows

We shall now discuss briefly some non-Newtonian flows. The main aim of this discussion will be to bring out the salient differences between the flow properties of the Newtonian and various types of non-Newtonian fluids.

A. *Rectilinear Motions* :

(a) *Flow through a circular pipe* :

We shall first discuss the rectilinear flow of a non-Newtonian fluid through a circular pipe of radius a with axis placed along the z-axis of the cylindrical coordinates (r, θ, z) under a constant pressure gradient $\frac{\partial p}{\partial z} = P$. The non-zero component of the velocity is the axial velocity w. In order to examine the possibility of the existence of the Merrignton effect we shall need T_{rr} and T_{zz} components of the stress tensor.

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Rivlin-Ericksen Fluids : For Rivlin-Ericksen fluids,[35] w, T_{rr} and T_{zz} are given by

$$w_r[\Phi_1+2\Phi_2 w_r^2+4\Phi_7 w_r^4] = \frac{1}{2} Pr, \quad w_r = \frac{dw}{dr}, \qquad \ldots \quad (3.1)$$

$$p(r, z) = C+Pz+W+\int \frac{W}{r}\, dr, \qquad \ldots \quad (4.2)$$

where C is the constant of integration, and

$$\left.\begin{aligned} T_{rr} &= -p+W \\ T_{zz} &= -p+\Phi_3 w_r^2 \end{aligned}\right\} \qquad \ldots \quad (3.3)$$

$$W = (2\Phi_2+\Phi_3)w_r^2+4(\Phi_4+\Phi_6)w_r^4+8\Phi_8 w_r^6. \qquad \ldots \quad (3.4)$$

If the stream of the fluid issues at the cross-section $z = 0$ into an atmosphere of constant pressure p_0, then equating the total force exerted on this cross-section by the fluid and the atmosphere, we find

$$C = p_0 - \frac{2}{a^2}\int_0^a r\left[\, W+\int \frac{W}{r}\, dr-\Phi_3 w_r^2 \,\right] dr \qquad \ldots \quad (3.5)$$

and therefore,

$$T_{rr}(z = 0,\ r = a) = -p_0+\frac{1}{a^2}\int_0^a r[(2\Phi_2-\Phi_3)w_r^2+4(\Phi_4+\Phi_6)(w_r^4) +8\Phi_8 w_r^6]dr \qquad \ldots \quad (3.6)$$

We can now note the following important points :

(i) The axial velocity w depends on the coefficients ϕ_1, ϕ_2 and ϕ_7 only so that for an inelastic fluid with $\phi_1 =$ constant, w is the same as in in the case of a Newtonian fluid.

(ii) For both elastic and inelastic fluids the pressure distribution over a cross-section is non-uniform in contradistinction to the Newtonian fluids.

(iii) The fluid stream at the exit $z = 0$ will certainly show swelling if the integral on the right hand side of (3.6) is negative. Consequently if Φ_i, $i = 4, 6, 8$ are negative definite and $\Phi_3 > 2\Phi_2$ for $0 < r < a$, the fluid will show the Merrington effect. A visco-inelastic fluid will show the Merrington effect if $\Phi_3 > 0$. Similarly a visco-elastic fluid for which $\Phi_i = 0$, $i > 2$, will also show the Merrington effect. Consequently, it is not possible to decide whether cross-viscosity or elasticity in the fluid is responsible for the Merrington effect.

(iv) Since in the case of the Ostwald fluids the whole burden of non-linearity of the constitutive relation is borne by Φ_1 which does not appear in (3.6), these fluids, just like the Newtonian fluids, will not show the Merington effect.

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Inlet length [*Bhatnagar and Rao*[4]] :

It is of some interest to record the change introduced in the value of the inlet length L over which the parabolic profile $w = \frac{\lambda}{4\mu}(a^2 - r^2)$ of the velocity will be established in a circular tube due to the presence of cross-viscosity taken as a linear function of II :

$$\Phi_3 = C_0 + C_1 \Pi.$$

The third term of the right hand side of the equation

$$\frac{P_E - p_{00}}{\frac{1}{2}\rho W_E^2} = 1 + \frac{16\mu L}{\rho a^2 W_E} + \frac{1}{\rho W_E}\left[\frac{\lambda}{2\mu} C_0 + \frac{5\lambda^2}{48\mu^2} C_1 W_E\right]$$

is the contribution of the cross-viscosity, where λ is the constant axial pressure gradient, p_{00} is the pressure at the centre of the entry cross-section, and

$$W_E = \frac{\lambda a^2}{8\mu}.$$

We find that, if c_0 and c_1 are both positive, the inlet length is decreased.

Oldroyd's fluids[26] :

For Oldroyd's fluids w, p, T_{zz} and T_{rr} are given by

$$w_r F(\gamma) = -\frac{P}{2} r \qquad \ldots (3.7)$$

$$p(r, z) = C - Pz + T''_{rr} + \frac{\eta P^2}{4} \int \frac{r dr}{F^2}\left[(\tau_2 - \mu_2) + \frac{(\mu_1 - \tau_1)}{\eta} F(\gamma)\right], \qquad \ldots (3.8)$$

$$\left.\begin{aligned} T_{rr} &= -p - [(\tau_1 - \mu_1 + \nu_1)F(\gamma) - (\tau_2 - \mu_2 + \nu_2)\eta)]\gamma^2, \\ T_{zz} &= -p + [(\tau_1 + \mu_1 - \nu_1)F(\gamma) - (\tau_2 + \mu_2 - \nu_2)\eta]\gamma^2, \end{aligned}\right\} \qquad \ldots (3.9)$$

$$F(\gamma) = \frac{\eta(1 + \sigma_2\gamma^2)}{1 + \sigma_1\gamma^2} \; ; \quad \gamma = w_r. \qquad \ldots (3.10)$$

$$\left.\begin{aligned} \sigma_1 &= \tau_1^2 + \mu_0(\mu_1 - \tfrac{3}{2}\nu_1) - \mu_1(\mu_1 - \nu_1), \\ \sigma_2 &= \tau_1\tau_2 + \mu_0(\mu_2 - \tfrac{3}{2}\nu_2) - \mu_1(\mu_2 - \nu_2). \end{aligned}\right\} \qquad \ldots ((3.11)$$

Once again equating the forces on the two sides of the cross-section $z = 0$, where the liquid stream is issuing out, we have

$$C = p_0 + \frac{2}{a^2}\int_0^a r dr[2r^2(\tau_1 F(\gamma) - \tau_2\eta)$$

$$-\eta\frac{P^2}{4}\int \frac{r dr}{F^2}\left\{(\tau_2 - \mu_2) + \frac{1}{\eta}(\mu_1 - \tau_1)F(\gamma)\right\}\Big], \qquad \ldots (3.12)$$

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so that

$$-[p_0+T_{rr}]_{\substack{z=0\\r=a}} = \frac{2}{a^2}\int_0^a rdr\Big[\, 2r^2(\tau_1 F(\gamma)-\tau_2\eta)$$

$$-\frac{\eta P^2}{4}\int \frac{rdr}{F^2}\left\{(\tau_2-\mu_2)+\frac{1}{\eta}(\mu_1-\tau_1)F\right\}$$

$$+\frac{\eta P^2}{4}\frac{1}{F^2}\left\{(\tau_2-\mu_2)+\frac{1}{\eta}(\mu_1-\tau_1)F\right\}\Big]. \quad \ldots \quad (3.13)$$

We now note that (i) the velocity w and the pressure distribution depend on all the eight rheological constants, (ii) the pressure over a cross-section is non-uniform in contradistinction to Newtonian fluids and (iii) the fluid will always show the swelling effect if the right hand side of (3.13) is positive.

In the particular case when $\tau_1 = \tau_2 = \mu_1 = \mu_2$, and $\nu_1 = \nu_2 = 0$, the Merrington effect is absent. It is also important to note that in the particular case when $\sigma_1 = \sigma_2$, the velocity distribution coincides with that of a Newtonian fluid, but the Merrington effect will still be present.

(b) *Couette Flow between two coaxial cylinders* :

We shall now discuss the steady flow of a non-Newtonian fluid between two vertical coaxial cylinders of radii and a and b ($> a$), when the inner cylinder is rotating with an angular velocity Ω_1 and the outer cylinder with angular velocity Ω_2. In this discussion our aim will be to study the possibility of the Weissenberg effect. We shall assume that the liquid extends downwards to infinity and has an upper free surface exposed to a constant atmospheric pressure p_0. In cylindrical coordinate system (r, θ, z) with z-axis along the common axis of the cylindres, the non-zero velocity component is $v = r\,\omega(r)$.

Rivlin-Ericksen Fluids[35] :

In the case of a Rivlin-Ericksen fluid, the angular velocity ω, pressure p, and T_{zz} component of stress are given by

$$\omega_r[\Phi_1+2\Phi_5 r^2\omega_r^2+4\Phi_7 r^4\omega_r^4] = \frac{M}{r^3}, \quad \omega_r = \frac{d\omega}{dr}, \quad \ldots \quad (3.14)$$

$$p(r,z) = C-\rho gz+\Phi_3 r^2\omega_r^2+W+\int\left[\rho r\omega^2+\frac{W}{r}\right]dr, \quad \ldots \quad (3.15)$$

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and

$$T_{zz} = \rho gz - \Phi_3 r^2\omega_r^2 - W - \int \left(\rho r\omega^2 + \frac{W}{r} \right) dr - C, \quad \ldots \quad (3.16)$$

where

$$W = 2\Phi_2 r^2\omega_r^2 + 4(\Phi_4 + \Phi_6) r^4\omega_r^4 + 8\Phi_8 r^6\omega_r^6, \quad \ldots \quad (3.17)$$

M and C are constants of integration, and z is measured from an arbitrarily chosen level inside the fluid.It is interesting to note that, (i) from (3.14) the angular velocity appears to depend on the coefficient Φ_1 in addition to Φ_5 and Φ_7; but when the actual velocity profile is evaluated with the help of the boundary conditions, Φ_1 does not appear in the final expression as for a Newtonian fluid,

(ii) the pressure distribution is independent of the ordinary viscosity Φ_1 as in the case of a Newtonian fluid,

(iii) the shape of the meridian section and the slope of the free surface are given by

$$\rho gz = \text{const.} + \Phi_3 r^2\omega_r^2 + W + \int \left[\rho r\omega^2 + \frac{W}{r} \right] dr \quad \ldots \quad (3.18)$$

and

$$\frac{dz}{dr} = \underbrace{\frac{r\omega^2}{g}}_{\text{effect of centrifugal force}} + \underbrace{\frac{1}{\rho g}\frac{d}{dr}\left[\Phi_3 r^2\omega_r^2\right]}_{\text{effect of cross-viscosity}} + \underbrace{\frac{1}{\rho g}\left[\frac{W_1}{r} + \frac{dW}{dr}\right]}_{\text{effect of visco-elasticity}}. \quad (3.19)$$

Hence either cross-viscosity alone or visco-elasticity alone or both will modify the shape of the meridian section of the free surface prescribed by the centrifugal force alone.

Newtonian fluid :

The angular velocity distribution is given by

$$\omega = \frac{\alpha}{r^2} + \beta; \quad \alpha = \frac{(\Omega_1 - \Omega_2)a^2b^2}{b^2 - a^2}; \quad \beta = \frac{b^2\Omega_2 - a^2\Omega_1}{b^2 - a^2} \quad \ldots \quad (3.20)$$

and the slope of the meridian section of the surface is

$$\frac{dz}{dr} = \frac{r\omega^2}{g}, \quad \ldots \quad (3.21)$$

so that the shape of the free surface is entirely governed by the centrifugal force which ultimately depends on the angular velocities of the cylinders.

Visco-inelastic fluid with variable coefficients [*Rathna*[30]] :

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Let

$$\Phi_1 = \beta\Pi^n \; ; \; \Phi_3 = \gamma_0+\gamma_1\Pi+\gamma_2\Pi^2+\ldots\ldots \; , \; n > 0, \neq \tfrac{1}{2}$$

where, β and γ_i are constants and

$$\Pi = 2r^2\omega_r^2.$$

Here

$$\omega = \frac{\alpha_1}{mr^m} + \beta_1, \qquad \ldots \quad (3.22)$$

where

$$m = \frac{2}{2n+1} \; ; \; \alpha_1 = \frac{m(\Omega_1-\Omega_2)(ab)^m}{b^m-a^m} \; ; \; \beta_1 = \frac{\Omega_2 b^m-\Omega_1 a^m}{b^m-a^m}.$$

The free surface is determined by

$$z = \text{const.} + \frac{\alpha_1^2}{\rho g}\;\frac{1}{r^{2m}}\left[\gamma_0+\gamma_1\left(\frac{\alpha_1}{r^m}\right)^2+\gamma_2\left(\frac{\alpha_1}{r^m}\right)^4+\ldots\right]$$

$$+\frac{r^2}{gm^2}\left[\frac{1}{2(1-m)}\left(\frac{\alpha_1}{r^m}\right)^2+\frac{\beta_1^2m^2}{2}+\frac{2\beta_1 m}{2-m}\left(\frac{\alpha_1}{r^m}\right)\right]. \qquad \ldots \quad (3.23)$$

When the inner cylinder is at rest, the liquid will climb along the inner cylinder and will climb or fall along the outer cylinder according as

$$\rho b^2\left[\left(\frac{b}{a}\right)^m-1\right]^2 \gtrless 2m^3\left[\gamma_0+2\gamma_1\left(\frac{\alpha_1}{b^m}\right)^2+\ldots\right], \qquad \ldots \quad (3.24)$$

which may be compared with the inequalities

$$\left(\frac{b^2}{a^2}-1\right)^2 \gtrless \frac{16\Phi_3}{\rho b^2}, \qquad \ldots \quad (3.25)$$

given by James Serrin[15] for the case of Reiner-Rivlin fluids with constant coefficients of viscosity Φ_1, and cross-viscosity Φ_3.

Similarly when the outer cylinder is at rest ($\Omega_2 = 0$), the liquid will fall at the outer cylinder and will climb or fall along the inner cylinder according as

$$\rho a^2\left[1-\left(\frac{a}{b}\right)^m\right]^2 \lessgtr 2m^3\left[\gamma_0+2\gamma_1\left(\frac{\alpha_1}{a^m}\right)^2+\ldots\right] \qquad \ldots \quad (3.26)$$

which may again be compared with the inequalities

$$\left[1-\left(\frac{a}{b}\right)^2\right]^2 \lessgtr \frac{16\Phi_3}{\rho a^2}, \qquad \ldots \quad (3.27)$$

given by James Serrin.[15]

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Visco-elastic fluid with Φ_1 *and* Φ_2 *as constants and* $\Phi_i = 0$ *for* $i > 2$:

The angular velocity distribution is the same as in the case of Newtonian fluids (3.20) and the shape of the free surface is given by

$$z = \text{const.} + \frac{6\alpha^2\Phi_2}{\rho g}\,\frac{1}{r^4} + \frac{1}{2g}\left[\,-\frac{\alpha^2}{r^2} + 4\alpha\beta \ln r + \beta^2 r^2\,\right], \qquad \ldots \quad (3.28)$$

so that

$$\left.\frac{dz}{dr}\right]_{r=a} \gtreqless 0 \text{ according as } \left(1-\frac{a^2}{b^2}\right)^2 \gtreqless \frac{24\Phi_2}{\rho a^2}\left(1-\frac{\Omega_2}{\Omega_1}\right)^2 \qquad \ldots \quad (3.29)$$

and

$$\left.\frac{dz}{dr}\right]_{r=b} \gtreqless 0 \text{ according as } \left(\frac{b^2}{a^2}-1\right)^2 \gtreqless \frac{24\Phi_2}{\rho b^2}\left(1-\frac{\Omega_1}{\Omega_2}\right)^2. \qquad \ldots \quad (3.30)$$

Thus we see that even the elasticity of the fluid alone is capable of producing the Weissenberg effect.

Oldroyd fluid[26] :

In this case we have the velocity distribution and the free surface given by

$$r^3\omega_r F(\gamma) = M, \qquad \ldots \quad (3.31)$$

and

$$\rho g z = \text{const.} + \int \rho r\omega^2 dr - [(\tau_1-\mu_1)F(\bar{\gamma}) - (\tau_2-\mu_2)\eta]\bar{\gamma}^2 - 2\int r\omega_r^2[\tau_1 F(\bar{\gamma}) - \tau_2\eta]dr, \qquad \ldots \quad (3.32)$$

where $\bar{\gamma} = r\omega_r$ with the other symbols defined as in (3.10) and (3.11).

In the particular case when $\sigma_1 = \sigma_2$ i.e.

$$\tau_2 = \tau_1 + \frac{1}{\tau_1}\left[\,\mu_0\left(\mu_1-\mu_2+\frac{3}{2}\,\nu_2-\frac{3}{2}\,\nu_1\right) - \mu_1(\mu_1-\mu_2+\nu_2-\nu_1)\,\right]$$

with necessary conditions on the other constants to ensure $\tau_2 > 0$, the angular velocity distribution is the same as for a Newtonian fluid and the equation to the meridian section of the free surface is

$$\rho g z = 2\alpha^2\eta\{(\tau_2-\tau_1)+2(\mu_1-\mu_2)\}\frac{1}{r^4} + \frac{\rho}{2}\left\{-\frac{\alpha^2}{r^2} + 4\alpha\beta \ln r + \beta^2 r^2\right\} + \text{const}, \qquad \ldots \quad (3.33)$$

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so that its slope is given by

$$\frac{dz}{dr} = -\frac{8\eta\alpha^2}{\rho g r^5}\{\tau_2-\tau_1+2(\mu_1-\mu_2)\}+\frac{r}{g}\left(\frac{\alpha}{r^2}+\beta\right)^2 .$$

In addition to $\sigma_1 = \sigma_2$, let us assume $(\tau_1-\tau_2) < 2(\mu_1-\mu_2)$, (i) then when the inner cylinder is at rest we find that the liquid rises at the inner cylinder and the slope along the outer cylinder is positive, zero or negative according as

$$b^2\left\{1-\frac{b^2}{a^2}\right\} \gtreqless \frac{8\eta}{\rho}\{(\tau_2-\tau_1)+2(\mu_1-\mu_2)\} \qquad \ldots \quad (3.34)$$

(ii) similarly when the outer cylinder is at rest we find that the liquid descends at the outer cylinder and the slope along the inner cylinder is positive, zero or negative according as

$$a^2\left\{1-\frac{a^2}{b^2}\right\} \gtreqless \frac{8\eta}{\rho}\{(\tau_2-\tau_1)+2(\mu_1-\mu_2)\}. \qquad \ldots \quad (3.35)$$

B. *Non-rectilinear flows* :

a) *Flow of a non-Newtonian fluid through a non-circular straight tube* :

A rectilinear flow of a Newtonian fluid in which the path lines are parallel to the generators of the tube is always possible. In the case of a non-Newtonian fluid, in general, such a flow is possible only in the presence of suitably distributed body forces. In the absence of these forces a secondary flow is introduced in the cross-sectional plane which does not depend on the position of the plane.

Flow of a Reiner-Rivlin Fluid with $\Phi_1 = 2\mu$, *a constant and* $\Phi_3 = \alpha_1-\beta_1\Pi_0+\gamma_1\Pi_0^2$ [Bhatnagar and Rao[4]]

For a tube having an elliptic cross-section $S \equiv \frac{x^2}{a^2}+\frac{y^2}{b^2}-1 = 0$, if we we take the cross-viscosity as a quadratic function of Π_0, the second invariant of the primary flow, the secondary flow is given by the stream function

$$\psi(x, y) = S^2(A_0xy+A_1x^3y+A_2xy^3), \qquad \ldots \quad (3.36)$$

where the coefficients A_i are expressible in terms of the semi-axes a and b, the constant coefficient of viscosity 2μ and the coefficients β_1, γ_1 defining the cross-viscosity. Thus the secondary motion consists of four similar

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vortex-like flows in each quadrant of the cross section, having the same sense in the opposite quadrants and the opposite sense in the adjacent quadrants as shown in Fig. 3. Even when the quadratic term in Π_0 in the

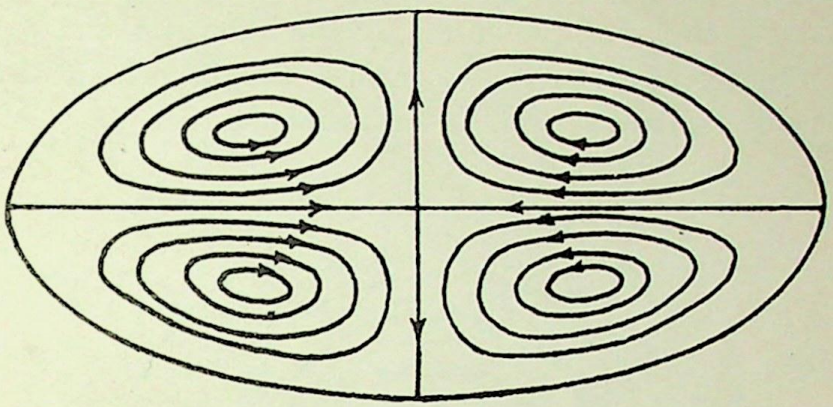


FIG. 3. SECONDARY FLOW IN A TUBE WITH ELLIPTICAL CROSS SECTION

definition of Φ_3 is absent, the case considered by Rivlin and Green[10] more or less simultaneously, the general features of the secondary flow are maintained. Though the existence of the secondary flows has been predicted theoretically only for a special class of non-Newtonian fluids, it is surmised that it is a common feature of the whole class. On the experimental side there is a certain amount of uncertainty : Roberts[38] suggests, on the basis of his experimental investigations, the possibility of the existence of rectilinear flows through non-circular tubes, while the investigations of Markovitz and Williamson[21] support the existence of secondary flows in such fluids.

(b) *Flow between two co-axial cones with common vertex* :

The flow of a Newtonian fluid, set up between two co-axial cones with common vertex and in relative rotation about their axis approximates to a rectilinear flow with path lines as circles about the axis, when the motion is so slow that the inertial terms may be neglected. In the case of a non-Newtonian fluid, whether it is characterized by Rivlin-Ericksen constitutive equation[6] or by the Oldroyd constitutive equation[26], even this type of slow motion is associated with a secondary flow in each meridian plane.

(c) *Flow through curved pipe with circular cross-section* :

The problem of the laminar flow of a non-Newtonian fluid in a curved pipe requires mentioning, for this is as yet an open problem. Let us consider a tube with a as the radius of a cross-section and b as the radius of the circle formed by the central line. If, for the sake of simplicity, we retain only

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the first power of (a/b) in the study of a Reiner-Rivlin fluid with constant coefficients of viscosity and cross-viscosity, then the curvature of the pipe does not affect the flow and the relation between the rate of flow and the impressed pressure gradient is the same as if the pipe were straight and the fluid Newtonian. However, as shown by the figures 4 and 5, drawn by Jones[17], the presence of cross-viscosity affects the disposition of the stream lines in the central plane as well as in a cross-section.

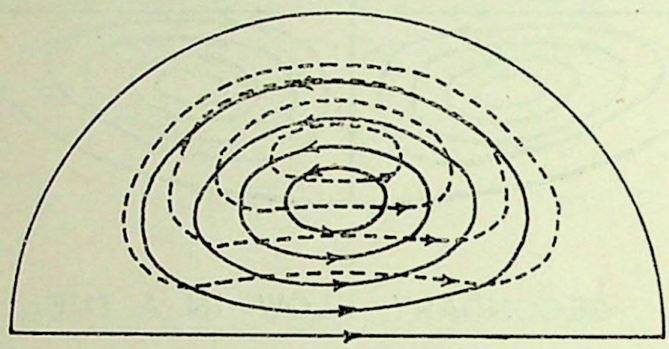


FIG. 4. CURVES OF INTERSECTION OF THE SURFACES
ψ = CONSTANT WITH A NORMAL SECTION
ϑ = CONSTANT WHEN S = 0 —— AND S = —1.4 - - - - - - - - - - - - [AFTER J.R.JONES]

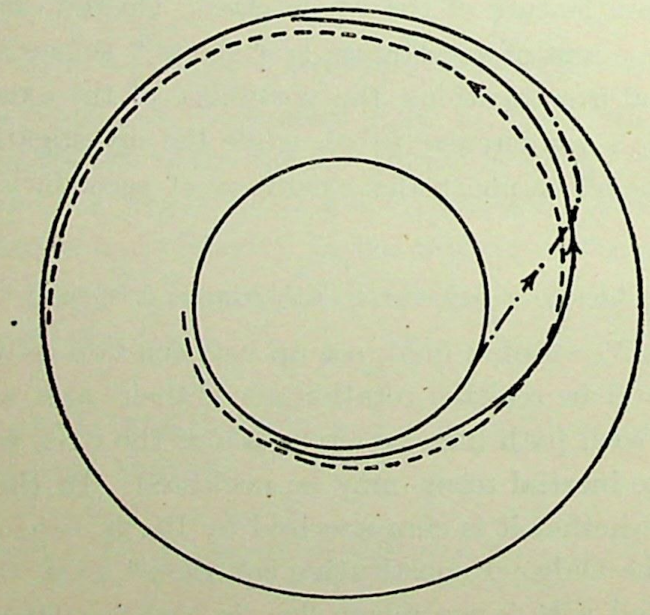


FIG. 5. STREAMLINES IN THE CENTRAL PLANE R = 63.3
—— S = 0
- - - - - - - S = —1.0
—·—·— S = +1.0
[AFTER J.R.JONES]

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(d) *Flow through a porous annulus between two coaxial circular cylinders* :

Let us consider the flow of a Reiner-Rivlin fluid with constant coefficients of viscosities through an annulus between two coaxial porous cylinders with radii a and b $(>a)$. As demanded by the equation of continuity, the rate of injection at one wall is equal to the rate of suction at the other wall. The axial velocity w can be expressed in an exact form in terms of two dimensionless parameters $R = \frac{bv(b)\rho}{\Phi_1}$ and $K = \frac{2\Phi_3}{\rho b^2}$, representing the effects of injection and cross-viscosity respectively;

$$w = -\frac{C}{2(R-2)}\left[\underline{\xi}^2-\sigma^2+\frac{1-\sigma^2}{(1-KR)^{R/2}-(\sigma^2-KR)^{R/2}}\left\{(\sigma^2-KR)^{R/2}-(\underline{\xi}^2-KR)^{R/2}\right\}\right]$$

$$\text{for} \quad 0 \leqslant KR < \sigma, \quad R \neq 2, \qquad \ldots \quad (3.37)$$

and

$$w = -\frac{C}{2(R-2)}\left[\underline{\xi}^2-\sigma^2+\frac{1-\sigma^2}{(KR-1)^{\frac{R}{2}}-(KR-\sigma^2)^{R/2}}\left\{(KR-\sigma^2)^{R/2}-(KR-\underline{\xi}^2)^{\frac{R}{2}}\right\}\right]$$

$$\text{for} \quad KR > 1, \quad R \neq 2, \qquad \ldots \quad (3.38)$$

where

$$C = \frac{b^2}{\Phi_1}\frac{\partial p}{\partial z}, \quad \underline{\xi} = \frac{r}{b} \quad \text{and} \quad \sigma = \frac{a}{b}.$$

When R is a positive even integer these two profiles are identical. When $\sigma < KR < 1$ and R is not a positive even integer, no value of w exists which is real throughout the flow field.

In the case of a Newtonian fluid [Berman[1]], the point of maximum axial velocity shifts from the inner cylinder to the outer cylinder as R increases from $-\infty$ to $+\infty$, i.e. the contribution of the radial velocity at the outer cylinder changes from infinite rate of injection to infinite rate of suction. A very interesting phenomenon occurs in the case of Reiner-Rivlin fluids with constant coefficients of viscosities as R increases from $-\infty$ to ∞. The point of maximum axial velocity shifts from the inner cylinder to some distance towards the outer cylinder and then, at some critical value of R, it begins to shift towards the inner cylinder. The profiles for $R \to -\infty$ and $R \to +\infty$ coincide [Narasimhan [23]].

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4. Boundary layer flows

(A) It is well-known that the introduction of the concept of boundary layer by Prandtl enabled at least an approximate solution of even complicated flow problems in the case of Newtonian fluids. In the case of non-Newtonian fluids, whose flow equations are considerably more complicated than the Navier-Stokes equations, the simplification of the equations using the boundary layer concept is certainly more desirable.

Let us now consider the flow of a Reiner-Rivlin fluid with Φ_1 and Φ_3 as constants, over a semi-infinite flat plate. If the viscosity and cross-viscosity have to play an equally important role as the inertial forces in shaping the flow, then by considering the orders of various terms in the equations of motion, we can show [Bhatnagar[2]] that $\Phi_1 = 0(\delta^2)$ as in the case of Newtonian fluid, and $\Phi_3 = 0(\delta^2)$ also where δ is the thickness of the boundary layer. In fact it has been shown that the two-dimensional boundary layer equations for these fluids are identical with those of Newtonian fluids provided we use a modified pressure

$$P = p - \tfrac{1}{2}\,\Phi_3 \left(\frac{\partial u}{\partial y}\right)^2,$$

instead of p. The importance of this result is evident : We can carry over the results of two-dimensional boundary layer studies in Newtonian fluids to this class of non-Newtonian fluids with a single alteration of pressure.

For the case of generalised Ostwald's constitutive equation, Tomita[43] has shown that in the case of a semi-infinite flat plate the boundary layer thickness $\delta = 0\left(R_e^{\frac{-n}{n+1}}\right)$, where the Reynolds number, Re, is given by

$$Re = \frac{\rho V^{2-1/n} L^{1/n}}{\mu^{1/n}},$$

L and V being some standard length and velocity used for rendering the quantities dimensionless.

We can establish the boundary layer equations in orthogonal curvilinear coordinates for the Reiner-Rivlin fluids with constant Φ_1 and Φ_3, or any other fluid defined above, following the procedure set up by Howarth[12] in the case of the Newtonian fluids assuming that the scale factors h_1, h_2, h_3 and their derivatives are of order unity. If, with the help of these equations, we study the boundary layer flows on rotating bodies of revolution like spheres and spheroids, we find that the flow near the poles resembles in nature the flow near a rotating disc [Rajeswari[29]] as in the case of the Newtonian fluids [Nigam[24], Fadnis[7]].

(B) Some problems pertaining to the non-Newtonian fluids have been solved approximately using the full equations of motion but ulti-

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mately taking a quartic or sextic velocity profile consistent with the boundary conditions as in the von-Kármán-Pohlhausen method [Srivastava[41,42], Sharma, [39,40], Rathna[31]]. Some of these problems have been reconsidered using an extremal point collocation method [Jain[13,14]].

Among other problems of this type we choose to discuss briefly the flow near a stagnation point with the specific purpose of pointing out an important fact about the dissipation of energy by cross-viscosity and visco-elasticity. Figure 6 represents the variation of the boundary layer thickness

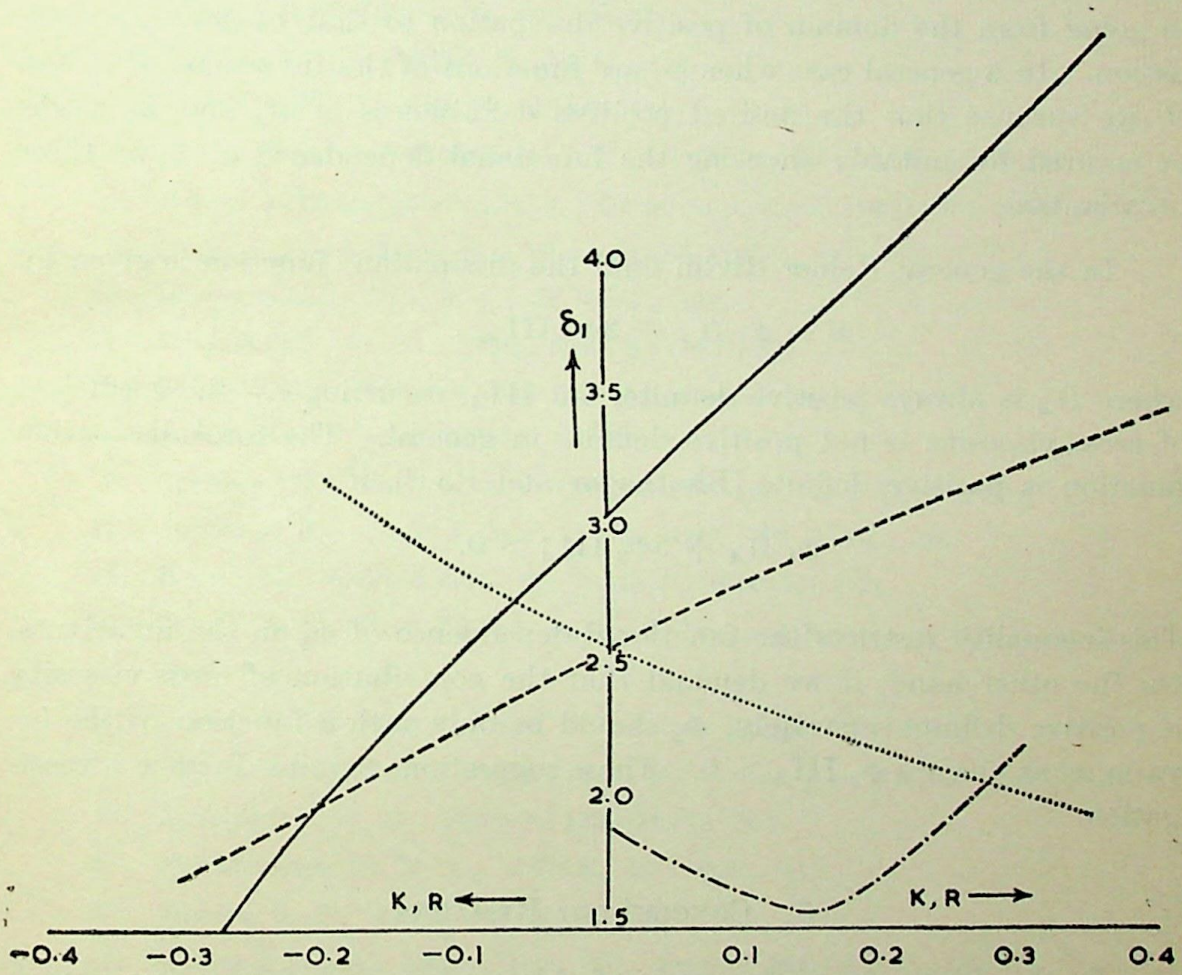


FIG. 6. VARIATION IN BOUNDARY LAYER THICKNESS WITH K AND R

with $K = \frac{\Phi_2 a}{\Phi_1}$ or $R = \frac{\Phi_3 a}{\Phi_1}$ for the sextic velocity profile [Rathna and Rajeswari[32]]. The general nature of the flow is the same as in the case of a Newtonian fluid except that the presence of cross-viscosity or visco-

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elasticity alters the disposition of the streamlines. If we denote the contributions of Φ_1, Φ_2 and Φ_3 to the total rate of dissipation of energy E by E_1, E_2 and E_3 respectively we can write

$$E = E_1 + E_2 + E_3.$$

E and E_1 are always positive definite but E_2 and E_3 are positive in certain domains and negative in the remaining domains of the flow field. If cross-viscosity and visco-elasticity also behave as ordinary viscosity, we expect their contributions also to be positive definite separately. If we accept this situation, then the coefficients Φ_2 and Φ_3 should abruptly change sign in going from the domain of positive dissipation to that of negative dissipation. In a general case when Φ_i are functions of the invariants of A and B, we surmise that the desired positive definiteness of E_2 and E_3 might be secured by suitably choosing the functional dependence of Φ_i on these invariants.

In the general Reiner-Rivlin fluid the dissipation function is given by

$$E = \Phi_1 \, \Pi_A + 3\Phi_3 \, \mathrm{III}_A,$$

where Π_A is always positive definite, but III_A, occurring as the coefficient of cross-viscosity is not positive definite in general. The total dissipation function is positive definite [Bhatnagar and Rao[3]], if

$$\Phi_1 \, \Pi_A + 3\Phi_3 \, \mathrm{III}_A > 0.$$

This inequality restricts the functional dependence of Φ_3 on the invariants. On the other hand, if we demand that the contribution of cross-viscosity is positive definite separately, Φ_3 should be only such a function of the invariants as ensures $\Phi_3 \, \mathrm{III}_A > 0$. These suggestions require further investigation.

5. Concluding Remarks

In this bird's-eye-view survey of this modern and fascinating branch of knowledge, I could not even touch upon some important topics like hydrodynamical theory of lubrication, heat transfer, compressibility and turbulence in non-Newtonian fluids on account of the limitation of space. I offer my apologies for this. The equations governing the non-Newtonian flows are intensely non-linear which need much sharper tools to deal with. Theory does not help us in choosing a proper constitutive equation and the experiments are too few to throw sufficient light on these questions. In fact, there are no direct methods available for the experimental determination of the various coefficients of viscosity. All these complications offer a challenge to the theoreticians as well as to the experimentalists. I hope that in the near future the challenge will be adequately met.

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SECTION OF STATISTICS

PRESIDENT : DR. C. CHANDRASEKARAN

Presidential Address

ESTIMATING HUMAN NUMBERS

—a Must for Planners and a Challenge to Statisticians

I deem it a great honour to have been elected the President of the Statistics Section of this 49th Session of the Indian Science Congress. In conferring this honour, I feel that you have not only emphasised the increasing importance for India of the subject of my special interest, viz, demography, but that you have also given your tacit approval for statisticians turning their attention in larger numbers to demographic studies. This is a happy augury, for, I am certain that the problems posed by the threat of future population growth are very grave indeed and unless mankind learns to set its house in order by good housekeeping, economic and social chaos might set in. Statisticians have an important role to play in providing the facts and figures with which problems of the human household can be reckoned and put right. Therefore, in addressing you today, I have chosen to speak of one of the important tasks of a demographer, namely, that of making future population projections, and of the handicaps under which he often has to work for lack of adequate information.

Every time a noted authority gives an estimate of world's future population, it makes headlines in the newspapers and strangely enough, even in countries with inadequate knowledge of the current population size, considerable interest is roused. Is this merely from the urge to have a glimpse into the future, which man from primitive times to the present day seems to have felt, an urge strengthened perhaps by the feeling that while the present has to be endured, the uncertain future can be expected to be more pleasant ?. In the modern world, attempts to estimate future population growth stem from a sense of realism and are oriented primarily to practical ends. It is now commonly realised that if plans for economic and social development have to be drawn up realistically, a parallel assessment of the dynamics of population growth is a vital necessity. Every project, whether it be an irrigation dam for increasing food production, a power supply scheme to cater to new industries or a school to educate the youngsters

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in a village, has to be planned with an eye on the future. Unless an approximate number of future consumers of various commodities and services—who will also supply the human element in production—is known, development planning cannot be sucessful in avoiding serious maladjustment between demand and supply.

World's Future Population

In recent years the Population Branch of the United Nations has been foremost in emphasising the need for population projections. To meet the needs of the various offices of the United Nations and governmental and private institutions, this agency has been continuously engaged in the preparation of future population estimates for countries, regions and the world as a whole. It may, however, come as a surprise to many that thrice within the course of about seven years, the United Nations Secretariat had to revise substantially its population estimates for periods upto 1980. On each occasion, three sets of estimates were given on high, medium and low assumptions. The estimates for 1980 prepared in 1951 gave figures between 2,976 and 3,636 million, with a range of 660 million. In 1954 revisions were made and the world population of 1980 was estimated between 3,295 and 3,990 million, the difference between the figures being 695 million. In the latest estimates made in 1957, the figure for the world population in 1980 has been revised from a low estimate of 3,850 million to a high estimate of 4,280 million, a range of 430 million. It may be noted that the estimates have successively been revised upward. Even the low estimates obtained in 1957 were near the high values estimated in 1954, and clearly outside the range of estimates made in 1951. Also, the range between the high and low estimates has narrowed from 660 million in 1951 and 695 million in 1954 to 430 million in the 1957 estimates.[18]

These changes in world population estimates are not due to differences in the methods used by the United Nations for the three sets of figures provided by them. The largest single factor which has determined upward revision of the populztion estimates was the data furnished by the first population census of the Chinese Mainland which was taken in 1953. This census showed that there were 583 million inhabitants on the Mainland in 1953 while a previous estimate made in 1948 had put the figure as 463 million. This higher figure for the population of China given by the 1953 census also implied that the rate of its population growth was probably much higher than what had been assumed earlier by demographers. In addition to the information on China's population, new facts that became known by 1957 suggested that in many countries of the world for which reliable vital statistics were not available, current and future declines in mortality were likely to be substantial and birth rates were not likely to decline in the near future.

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A recent population count and some information on the levels and trends in birth and death rates are the minimum requirements for estimating future population by modern demographic techniques and, unfortunately, such basic information is not available for many countries in the world. Prior to 1950's countries having this minimum, information probably did not include more than 20 per cent of the world's population. Largely due to the efforts of the United Nations, more and more countries are now taking a population census. Around the 1950's, about 75 per cent of the world's population was enumerated by a census. In the 1960's this percentage is expected to increase. However, the information on vital statistics is still extremely deficient. It is doubtful if even today, accurate birth and death data are available for more than 30 per cent of the world's population. It is under such conditions that the United Nations Organisation is making a bold attempt to provide projections of the world's population. The methods it has developed of obtaining approximate population estimates with only limited data at hand have been a notable contribution to the field of demography.[17]

Population Projections in the West

Given the base population, the task of making population projections becomes primarily one of estimating changes in population size because of births, deaths and migration. Even in Western countries with a long history of census-taking and where statistics of births, deaths and international migration are systematically collected, attempts at population proections have not always come close to reality. Inadequacies of techniques used have not been the major factor making for inaccurate estimates. Sometimes even a simple technique of straightforward mathematical extrapolation has worked well and has given a good estimate whereas on other occasions even refined methods have failed to give estimates within a tolerable margin of error. The experience of the United States well illustrates this point.

Pearl and Reed could forecast the 1920 and 1930 populations of U.S.A. with an error of less than one per cent by fitting a logistic curve to the census data from 1790 to 1910, but the 1940 population was overestimated by 3.5 per cent. [14] More refined methods, using the more adequate information that was becoming available, were subsequently evolved and Whelpton at the Scripps Foundation prepared a series of projections by what is now known as the "component method". [20] The first of these projections, made in 1928, missed the 1930 enumerated population by less than one per cent but overestimated the 1940 census population by somewhat more than 5 per cent. Within four years of the release of the first projections, Whelpton revised his estimates and set the figure of 150 million as the maximum which the population of the United States would reach before the end of the present century. A revised set of his estimates, published by

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the Bureau of the Census, indicated that a maximum of 165 million would be reached around the year 1990, after which a decline would occur. [21] All these estimates proved to be far out of the mark by 1960 when the census recorded a population of 179 million.

The divergences of population projections from the actual census counts have drawn sharp criticisms against demographers and their techniques. Professor Joseph S. Davis of the Food Research Institute at Stanford University remarked with indignation : "I am ashamed, that like most of my fellow scientists, I have long accepted the conclusions of the population specialists with naive faith.....it is disheartening to assert that the best population forecasts deserve little credence even for 5 years ahead and none at all for 20-50 years ahead.....Population forecasting is *not* a simple matter. Available techniques do *not* permit reliable prediction to be made for 5, 10, 20 or 50 years ahead. The best may be *far* wrong". [6] Professor Davis went so far as to suggest a return to qualitative wisdom as a forecasting method.[7]

Demographers are conscious that the population projections they make can go wrong. Most of them recognise that in making population projections they are not attempting to make forecasts but are merely presenting reasonable estimates of future population based on plausible assumption regarding trends in birth-rates, death rates and migration. Being among the first to know how the projections are behaving and the reasons for their departure from reality, demographers are both willing and able to provide revised sets of estimates which can be useful guidelines for policy-making.

In the United States experience referred to above, fertility has been the villain of the piece and population projections have been found wanting because of sharp and unforeseen rise in birth rates. Writing in 1955, Hajnal, who has worked extensively on fertility problems observed: "It seems almost impossible that anyone, however, great his ingenuity and however extensive his knowledge of the facts could have foreseen the "baby boom" of the 1940's. Someone who realised what is now known about the possibilities of "bunching" of births (as a result of changes in the pattern in which successive cohorts distribute their births over time) might have taken a more cautious attitude to the forecasts of population decline, but he could hardly have foreseen birth rates as high as those of the 1940's."[12]

It is, of course, true that the analytical methods used to prepare population projections need constant study and improvement. As often happens in most scientific fields, rapid advances are made when unexpected events take place and demography has been no exception to this rule. The "baby boom" of the 1940's has led to novel and refined methods of analysing

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levels of and trends in human fertility. Such analysis can to some extent be done with the available statistics but even in the more advanced contries there is need for additional information. The range of information which the demographer now seeks far exceeds the usual definition of "vital statistics" and includes such items as future plans and expectations. To illustrate, in 1955, the Scripps Foundation and the Survey Research Centre of the University of Michigan jointly sponsored an interview survey of a national sample of White women. One of the main purposes of this study was "to collect data on the number of births expected by such women, and to use this information in preparing population projections.[11]

Projections made by new and more complex techniques are just as likely to be upset as those made in the past. Yet, the demand for projections is continuously growing all over the world. Planners for economic and social development are paying increasing attention to future population growth in setting their targets. The three reports outlining the Five Year Plans of India bear testimony to the importance attached by our Planning Commission to population projections and point to the need for greater attention being devoted to this subject.

Population Projections for India

Early attempts at projecting population in India were made by extrapolating past trends in population growth. Swaroop and Lal fitted a logistic curve three years prior to the 1941 census and underestimated the population of 1941 by some 47 million or 12 per cent.[16] Raja also gave estimates for 1941, both by fitting the logistic curve and by projecting the recorded natural increase.[15] His estimate by the logistic curve was 5.8 per cent short of the recorded figure for 1941 while the other estimate which he preferred was in excess by about 3 per cent. Kingsley Davis gave three projections of India's population about a year before the 1951 census using three alternate assumptions :(1) the population will continue to increase at the rate of 1.2 per cent per year observed during 1921-41; (2) the population will increase at the rate of 0.6 per cent per year observed during the period 1871-1941; and (3) a logistic law of growth.[8] Compared with the total enumerated population of India and Pakistan in 1951, the estimates given by the first and the third assumptions were in error by 0.2 and 0.5 per cent respectively while the one given by the second assumption gave an underestimate of 5 per cent. It seems that extrapolations of recent past proved satisfactory because the rate of population growth was fairly steady over the period 1921-1951.

Since the 1951 census, several projections have been worked out for India's population. The Registrar-General gave projections based on

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the growth rates during the periods (1)1921 to 1951 and (2) 1941 to 1951. Das Gupta and Majumdar used the'component method'' for making projections and gave, in 1954, five sets of projections, making different assumptions concerning changes in mortality and fertility.[5] The same method was used by many others, including Coals and Hoover, and an expert committee appointed by the Planning Commission with different assumptions concerning the trends of mortality and fertility.[4,9] The upper values of the estimates of 1961 population given by the several projections are compared with the actual count in Table 1.

All the projections seem to have underestimated the population growth in the intercensal period 1951-61, but the projection given by the expert committee, which differed from the actual count by 1.6 per cent, has proved to be the closest to the actual count. Reckoned against the growth recorded between the 1951 and 1961 censuses, the estimate showed a difference of 9 per cent. Estimates worked out earlier in the decade 1951 to 1961 have differed more from the actual census count than those made later in the decade.

The reason is not far to seek. Since 1951, death rates have been exhibiting a rapid decline and in the absence of reliable death statistics, it has been difficult for demographers to gauge the extent of this decline. Estimates made earlier in the decade have erred on the side of caution by assuming a slow decline. Estimates made in the second half of the decade could assume large reductions in the death rate which were becoming apparent. The expert committee making its projections in 1959 had the benefit of the data on births and deaths collected in the first sub-round of the 14th Round of the National Sample Survey, which had revealed a substantial decline in the death rate.

The expert committee's projections were based on the following major assumptions :

(1) fertility will remain unchanged between 1951 and 1966 (a general fertility rate of 0.189 consistent with a birth rate of 42 per 1000 around 1951 will prevail over the period);

(2) mortality will decline such that the expectation of life at birth will steadily increase from 32 years in 1946 to 50 years in 1966; and

(3) the fall in the Indian life table death rates will be the same as that given by the appropriate United Nations Model life tables.

In making these assumptions, the committee not only made the most of the available demographic data but also relied heavily on the techniques developed by the United Nations. The factual information available in India was that obtained in a few demographic surveys, and the birth and

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death data given by the National Sample Survey, particularly its 14th Round. These data were by no means adequate to estimate the demographic changes that were taking place in different parts of the country, neither could they give an indication of the sharp downward trend in the crude and specific death rates. Under such circumstances an error of about 7 millions in the expert committee's projection of the 1961 population may be overlooked but the difference was large enough to disturb the Planning Commission which was about to finalise the Third Five Year Plan, and was concerned with the adequacy of the projections made by the committee for periods beyond 1961.

The Planning Commission, therefore, convened another committee to examine this question and in revising the projections this committee assumed that :

(1) mortality had declined faster than had been anticipated and the expectation of life at birth in 1961 was 47.5 years instead of 45.5 years as envisaged earlier;

(2) in view of the rapid rate at which expectation of life at birth had already risen, further increases will be slower, i.e., 0.75 per year annually upto 1966 and 0.5 per year from 1966 to 1976; and

(3) fertility will not decline till 1966 after which the fall will be either
   (a) negligible during 1966 to 1971 and 5 per cent during 1971 to 1976, or
   (b) negligible during 1966 to 1971 and 10 per cent during 1971 to 1976, or
   (c) 10 per cent during 1966 to 1971 and a further 20 per cent during 1971 to 1976.

Projections using alternate assumption 3(c) for fertility decline give a population of 611 million for 1976, about 14 million less than that given by assumption 3(b) which has been used by the Planning Commission in the Third Five Year Plan. The estimate given by assumption 3(a) is still lower.[10]

In making these assumptions, the new committee did not have access to much more demographic data than the earlier committee. All that the new committee had attempted to do was to adjust the decline in the death rate during 1951 to 1961 to give a rate of population growth consistent with what had been observed between the 1951 and 1961 censuses, the tacit assumption being that fertility had not changed during the period. Information which will be coming out of the Census Commissioner's office in the near future, especially that relating to the age-sex distribution of the population, will indicate whether the committee has advised rightly or not.

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If the projection closest to the total population recorded in 1961 was off the mark by about 7 million, how successful were the efforts at estimating the population by states ? Table 2 gives a comparison of the population projections for the different states as worked out by the expert committee with the actual census counts. The variations are considerable. In West Bengal, for instance, the estimate was 15 per cent below the census figure. In Assam, Madhya Pradesh and Orissa the estimates were 6 to 8 per cent below the actuals recorded while in Madras the estimate was 7 per cent in excess of the actual. These differences become even more significant when assessed against the intercensal growth as shown in Table 3. For West Bengal the expert committee gave a figure for population growth which was only 39 per cent of that shown by the census. In Assam, Madhya Pradesh and Orissa, the growth as given by the committee was 70, 60 and 64 per cent, respectively, of that recorded by the census. On the other hand, in Madras the committee gave a growth which was 166 per cent of that given by the census.

In making the State projections, the expert committee had used the "ratio method". The total population for India was first estimated and it was apportioned between the different States according to ratios which were obtained by projecting the past trends in the ratios of state populations to the total. The application of the "ratio method" was inevitable in the circumstances in which the committee had to work, without data on births, deaths or inter-State migration. In the context of modern India, is it surprising if such assumptions implying a mere projection of the experience of past decades should prove to be wrong ?

The accuracy of the figures of the State populations as revealed by the 1961 census has been questioned by some especially with regard to those States for which the census figures revealed rates of population growth which were either too high or too low, as compared with that for the population for all-India. To a limited extent, it would be possible for demographers to throw some light on this question when detailed tabulations of the census data are published. Our inability to deal with the question meanwhile is essentially a reflection of the lack of data on the dynamics of population growth in terms of birth, deaths and migration. In a study done at the Demographic Training and Research Centre, Bombay, attention was paid to an examination of the growth rate for Madras State which recorded only 11.7 per cent increase during the decade 1951 to 1961.[19] In this study, the average birth and death rates during the decade were estimated as 33 per 1000 and 17 per 1000 respectively and it was shown that the actual increase recorded by the 1951 and 1961 censuses can be accounted for, if there had been an average net out-migration of about 4 per 1000 persons per year. As indicated earlier, there are no independent sources

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of data against which the estimated birth, death and migration rates for the decade 1951 to 1961 could be checked.

Need for Additional Data and Research

I have so far dealt with some of the difficulties which a demographer has to face when he is called upon to make population projections. Population projections become a relatively simple affair, when mortality and fertility conditions are stable, and there is little or no migration. In such circumstances, thanks to the pioneering work of man like Lotka, the average demographer of today can prepare a profile of the population for several decades, given only the date of two censuses or large-scale sample surveys. But conditions in the present day world are changing fast and it will be essentially in such dynamic setting that demographers will be required to make population projections. The difficult situations of yesterday are likely to become the normal under which demographers will have to work in future, and it is in such settings that their ability to perform well has to be ensured.

As emphasised earlier, the demands made on the demographer are also becoming more varied and complex in this era of economic and social planning. Besides the projections of total population, estimates of manpower resources, labour force, school-going population and even of households and housing requirements—separately for cities and other urban and rural areas—are essential for working out plans for economic and social development. As the importance of perspective planning comes to be widely recognised, more difficult projections such, as those of skilled personnel in different occupational categories, will be required. How are we to prepare ourselves to meet these requirements adequately ?

Speaking particularly for India, vigorous action on two fronts seems imperative. More data have to be collected and demographic research needs to be intensified.

The need for additional data does not require much elaboration before this assembly of statisticians. It would, however, seem appropriate to emphasise some of the urgent requirements of demographers in this country. The largest wealth of material for their work is derived from the decennial censuses of population. By its very nature the census is huge undertaking and it is neither possible nor perhaps necessary to conduct censuses at more frequent intervals or to include all items of interest to the demographer in a census. Even the 1961 census schedule did not include questions on fertility, which are becoming a regular feature of censuses in many countries. The position of routine vital registration being what it is in this country,

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the levels of birth and death rates have to be estimated within large margins or error from the census data or have to be obtained from sample investigations such as the National Sample Survey. The value of sample survey data for making population projections for India has already been acknowledged by the use which the expert committee could make of the birth and death rates as given by the 14th Round of the National Sample Survey. The sample survey of households offers the most promising method for obtaining demographic data in situations as those in India and a wider application of this method should be considered a necessity.[3].

Two other suggestions with respect to data requirements seem pertinent. It is apparent that if the trend in a rapidly changing situation is to be understood, observations should be available at frequent intervals. The proposal of an annual sample census of population, which will also include the collection of data on births and deaths, and will provide valuable information to the demographer, is commendable and the appropriate authorities would do well to implement it without delay. Another equally important point to be considered is the fact that in India with its large area and cultural diversities, there is need to study demographic transitions in relatively small population groups. The sample surveys undertaken should, therefore, be so planned that adequate estimates on demographic characteristics will become available at least at the State level.

The main areas of demographic research that require immediate attention are the trends in mortality, fertility and migration and the factors associated with these trends. The need for studies in the field of mortality has been emphasised by me earlier while discussing the population projections for 1961 made for India. The importance of research in the field of fertility is now being increasingly realised. This importance stems from two considerations. One is the recognition that the trend in fertility is more important that the trend in mortality in affecting the age-structure of the population; and without accurate knowledge of the age-structure, detailed projections required for purposes of economic and social planning cannot be made. The other consideration is that with economic and social development fertility may tend to increase or diminish, and the trends may be different in different sections of the population. The experience of Western countries referred to earlier has shown the extent of fluctuations that may occur in the birth rate. In India various factors are at work which may tend to decrease or increase fertility. The large-scale family planning programme that has been initiated under the Five Year Plans would tend to reduce fertility. On the other hand there are also factors both institutional and physiological which may tend to increase fertility.[2] The effects of these several factors, both jointly and singly, have to be studied by demographers in collaboration with scientists in other fields.

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Demographic research in the field of migration is still meagre in India, in spite of an impetus indirectly given to it by the numerous city studies sponsored by the Research Programmes Committee of the Planning Commission. This deficiency has partly been due to the fact that censuses preceding that of 1961 have not obtained much information on the subject. The only question pertinent to migration asked in previous censuses was the one on 'birth-place' and as pointed out by Bogue birth-place data give an extremely limited picture of internal migration.[1] In the absence of information on 'duration of residence', studies done with the census material suffer from severe limitations. The 1961 census has in addition to the tranditional data on birth place obtained information on 'duration of residence' and the rural-urban character of 'birth-place' and it is hoped that the analysis of the census data will enrich our knowledge on the volume and direction of internal migration and on the economic and social characteristics of migrants. Statisticians and other social scientists may well collaborate in such studies.

* * * *

I began this address by making an appeal to statisticians to interest themselves in demographic studies. I cannot close better than by quoting kindred sentiments expressed by Walter E. Hoadley, Jr., who, in his presidential address to the American Statistical Association three years ago, said : "Most people will agree that statistics have their greatest importance as an aid to policy-making and the decision process. Better information obviously has some value *per se*, but unless it contributes to improvement of some decision-making process, it really adds little or nothing to the betterment of mankind. Policy decisions invariably concern the future. Hence, if statistics and statistical techniques, are to be useful, they too must point to the future. In my judgement, statisticians should have a continuing and aggressive interest in data interpretation and in forecasting as an aid to policy-making in whatever capacity and field they serve since presumably they know more about statistics than anyone else."[13]

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TABLE 1

COMPARISON OF DIFFERENT ESTIMATES OF 1961 POPULATION OF INDIA WITH THE ACTUAL COUNT

(Figures in millions)

A. Upper Values of Projections by	
1. K. Davis	402
2. Registrar General (1951)	407
3. A. J. Coale & E. H. Hoover	424
4. A. Das Gupta	404
5. T. Chellaswami	424
6. S. N. Agarwala	423
7. Planning Commission Expert Committee (Figure accepted for the Third Plan)	431*
B. Actual Count	438*

* Inclusive of Jammu and Kashmir, which recorded a population of 3.6 million in the 1961 census.

Source : Office of the Registrar General, India, 1961 *Census : Provisional Population Totals*, p. xii.

TABLE 2

COMPARISON BETWEEN EXPERT COMMITTEE'S ESTIMATE AND ACTUAL COUNT IN 1961 FOR DIFFERENT STATES

State	Estimate in millions	Actual in millions	Excess or deficit of estimate from actual (percent)
Andhra Pradesh	37.21	35.98	+ 3.42
Assam	10.96	11.86	— 7.59
Bihar	44.99	46.46	— 3.16
Bombay (including Maharashtra & Gujarat)	59.34	60.11	— 1.28
Kerala	17.16	16.88	+ 1.66
Madhya Pradesh	29.86	32.39	— 7.81
Madras	35.98	33.65	+ 6.92
Mysore	24.04	23.55	+ 2.08
Orissa	16.53	17.57	— 5.92
Punjab	19.80	20.30	— 2.46
Rajasthan	19.63	20.15	— 2.58
Uttar Pradesh	74.26	73.75	+ 0.69
West Bengal	29.69	34.97	—15.10
Delhi	2.55	2.64	— 3.41
Himachal Pradesh	1.15	1.35	—14.81
Jammu & Kashmir	5.31	3.58	+48.32

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TABLE 3

COMPARISON BETWEEN EXPERT COMMITTEE'S ESTIMATE OF POPULATION GROWTH FOR THE PERIOD 1951 TO 1961 WITH THAT GIVEN BY THE 1951 AND 1961 CENSUSES, BY STATE

State	Estimated increase (in millions)	Intercensal increase (in millions)	Estimate as percent of intercensal increase
Andhra Pradesh	6.09	4.86	125.3
Assam	2.13	3.03	70.3
Bihar	6.20	7.67	80.8
Bombay	11.09	11.86	93.5
Kerala	3.61	3.33	108.4
Madhya Pradesh	3.79	6.32	60.0
Madras	5.86	3.53	166.0
Mysore	4.64	4.15	111.8
Orissa	1.88	2.92	64.4
Punjab	3.66	4.16	88.0
Rajasthan	3.66	4.18	87.6
Uttar Pradesh	11.05	10.54	104.8
West Bengal	3.39	8.67	39.1
Delhi	0.81	0.90	90.0
Himachal Pradesh	0.04	0.24	16.7
Jammu & Kashmir	2.05	0.32*	640.6

*No census was taken in Jammu & Kashmir in 1951. For purposes of this calculation the 1951 population has been assumed to be the mean of the 1941 and 1961 populations.

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SECTION OF PHYSICS

PRESIDENT : PROFESSOR VIKRAM A. SARABHAI, M.A. Ph.D., (Cantab)

Presidential Address

COSMIC RAYS AND INTERPLANETARY SPACE

Our atmosphere has rather restricted windows through which, from the surface of the earth, we can study the universe which lies beyond it. Visible light and short radio waves provide two important windows. Cosmic rays furnish a third. I shall be dealing here with information which study of cosmic ray time variations has given about the physics of the sun and of interplanetary space, a field which has interested me personally for the past 15 years and which is the central theme of research by the cosmic ray group at the Physical Research Laboratory, Ahmedabad. In order to understand how cosmic rays can yield information of our environment in the solar system and in the galaxy, we should first appreciate what these rays are.

2. WHAT ARE COSMIC RAYS ?

What we generally measure as cosmic rays at depths in the atmosphere exceeding a few gm/sq.cm. of air are secondaries produced through nuclear interactions of primary particles in the upper atmosphere. We shall be concerned here mainly with the primary intensity about which views have changed somewhat radically over past decades. Our ideas about the origin of cosmic rays have also changed considerably and a good account of these has recently been given by Ginzburg and Syrovatsky[1]. I cannot do better than draw on them to summarise some important observational evidence which is relevant to our task.

An estimate of the chemical composition of primary cosmic rays is given in Table 1. It indicates fluxes of cosmic ray primaries with various atomic numbers and compares abundances of elements in the universe—two sets of basic data which give a clue to the fragmentation probability and the nuclear lifetime of cosmic rays. The research group at the Tata Institute of Fundamental Research in Bombay has made important contributions in studying the chemical composition of cosmic rays. Cosmic rays are much

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poorer in light elements than the region of the universe known to us. The ratio of the number of protons and α particles to the number of heavy nuclei is on the average almost two orders of magnitude smaller in cosmic rays than in the universe. The groups of light (L), medium (M), heavy (H) and very heavy (VH) nuclei are not subdivided in the table, but we should note that there is more boron than lithium and more carbon than oxygen in cosmic rays, whereas in the universe, on the average, the opposite is true.

TABLE 1

CHEMICAL COMPOSITION OF PRIMARY COSMIC RAYS COMPARED WITH UNIVERSAL ABUNDANCES. GINZBURG AND SYROVATSKY[1].

Group	Z	$\bar{A}$	Intensity, I (particles/m^2 sterad-sec)	Number of nucleons in the flux.	$I/I_H = N/N_H$ Cosmic Rays	Average N/N_H in the universe
p	1	1	1300	1300	520	6830
α	2	4	88	352	35	1040
L	3–5	10	1.9	19	0.76	10^{-5}
M	6–9	14	5.6	78	2.24	10.1
H	$\geqslant 10$	31	2.5	78	1	1
VH	$\geqslant 20$	51	0.7	35	0.28	0.05
The total number of nucleons = 1827						

Electrons and γ-rays are not shown in Table 1, for until recently we had no evidence in support of them. However, the very recent discovery (Earl[2] as well as Meyer and Vogt[3]) of relativistic electrons in primary cosmic rays is of major significance, even though it is not yet clear whether these are of galactic or solar origin. A search for γ-rays of $E \geqslant 10$ Mev is also important and experiments are now in progress to detect these.

At a given geomagnetic latitude (i.e. at specified magnetic rigidity) the nucleons contained in the nuclei with $Z \geqslant 2$ carry almost half the cosmic ray energy. Over a wide range of energies, the particle flux of cosmic rays has a power-law dependence on energy with the exponent of the differential spectrum having the same value $\gamma = 2.5 \pm 0.2$ for different cosmic ray charge groups, within the limits of accuracy of measurements. There is some indication that at the highest energy when $E \geqslant 10^{16}$ ev, the exponent increases to $\gamma = 3-3.2$. At most times, there is a low energy cut-off of the primary spectrum at about 0.7 Gev., but the cut-off is dependent on the

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cycle of solar activity and is clearly a modulation effect related to the solar system. So are the eleven year changes of energy spectrum and of cosmic ray intensity which are illustrated in Figures 1 and 2 respectively.

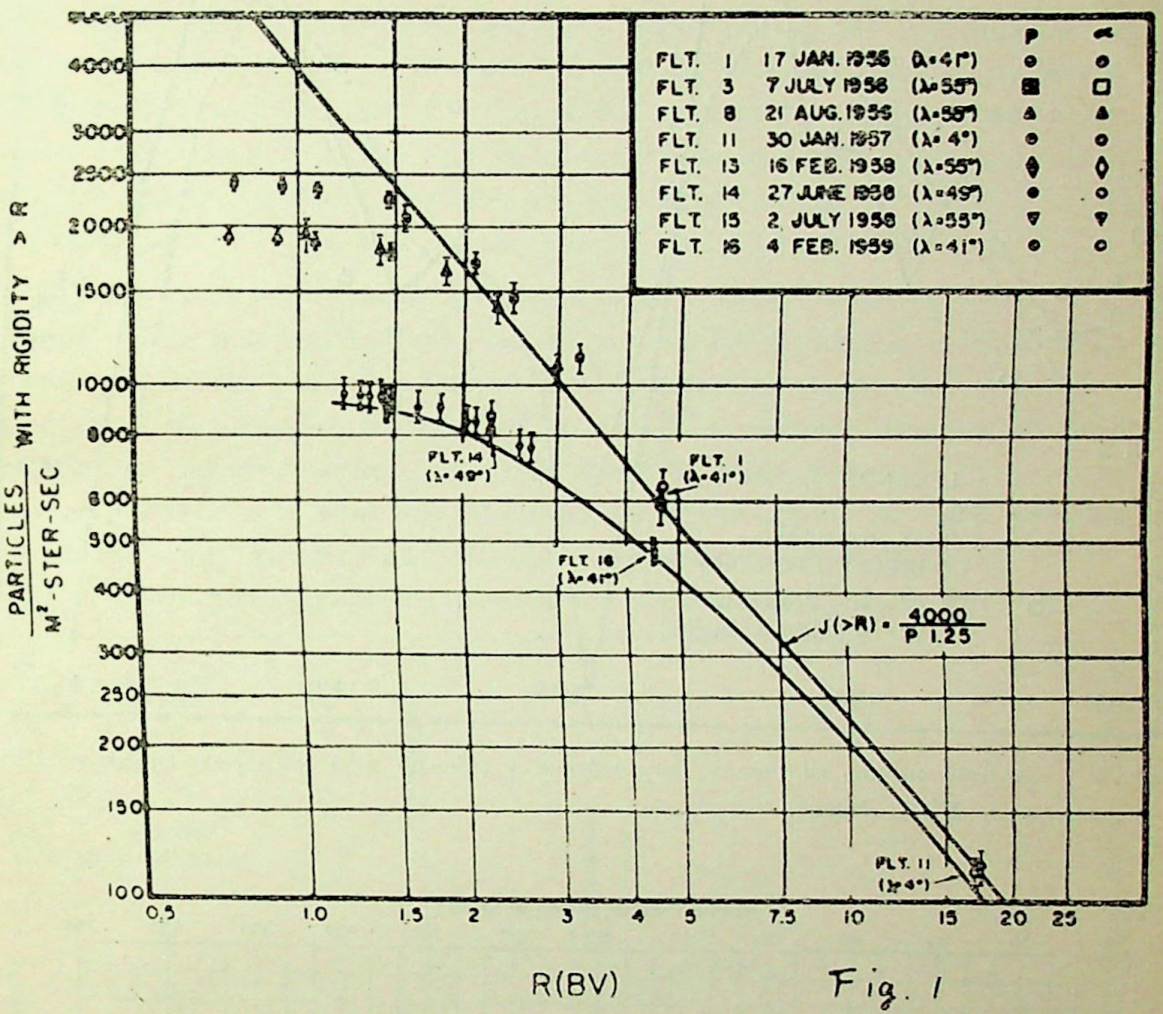


Fig. 1. Integral rigidity spectra of protons and α- particles during 1955-56 and 1958—F. B. McDonald[4].

An important additional piece of information concerns the sidereal anisotropy of cosmic rays. Many attempts have been made to detect such an anisotropy. Chitnis, Clark and I[6] have studied at Kodaikanal the directions of arrival of cosmic ray primaries producing extensive air showers. The direction of arrival of each shower was measured by time delays in detection by 4 scintillators placed at the corners of a square. The results of this experiment are shown in Fig. 3. There is no evidence of anisotropy in the celestial arrival directions of over 100,000 primaries with energy of about 10^{15} ev. Very recently, however, it has been reported by the MIT group as well as by the group at Tokyo that a sidereal anisotropy may be present for cosmic ray primaries with energy in excess of 10^{17} ev.

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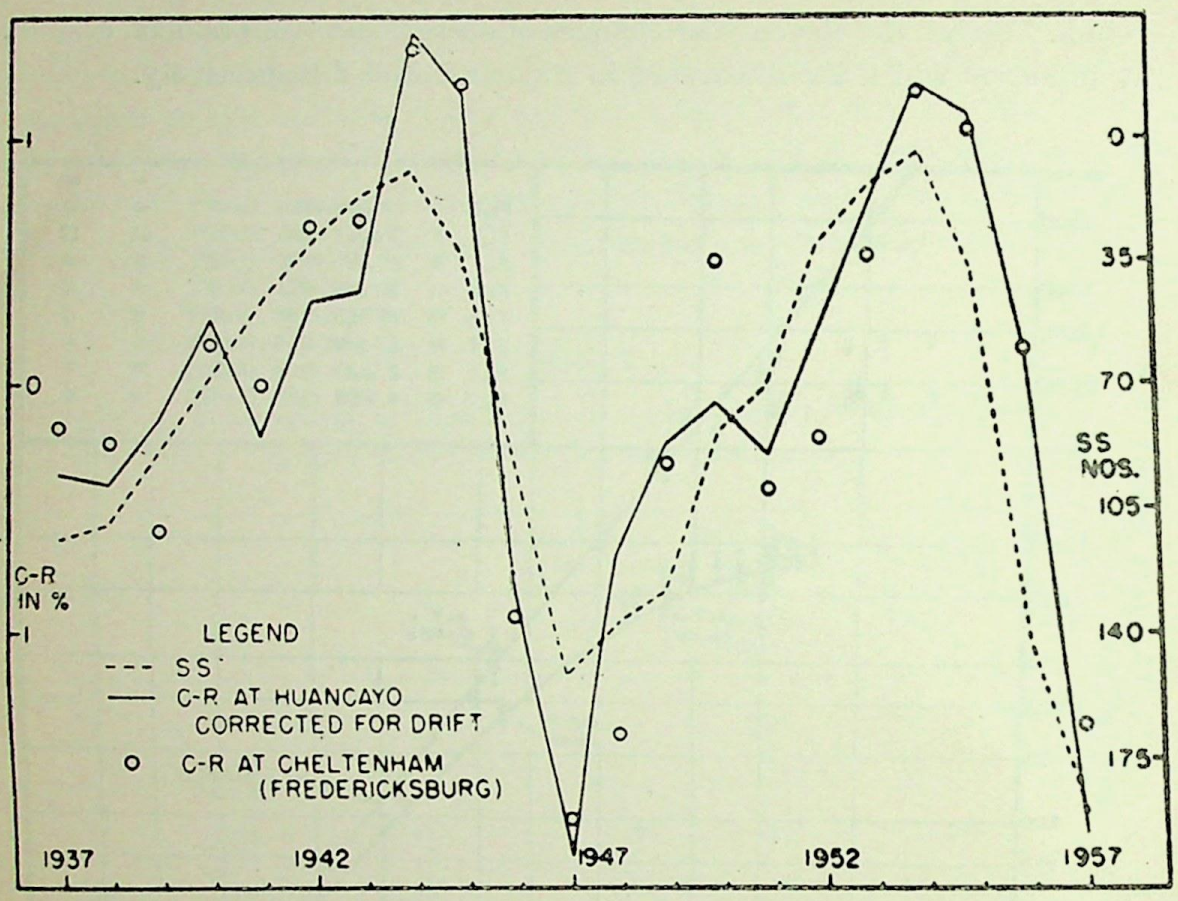


Fig. 2. Annual means of cosmic ray intensity (C—R) and sun-spot numbers (SS) —S. E. Forbush[5].

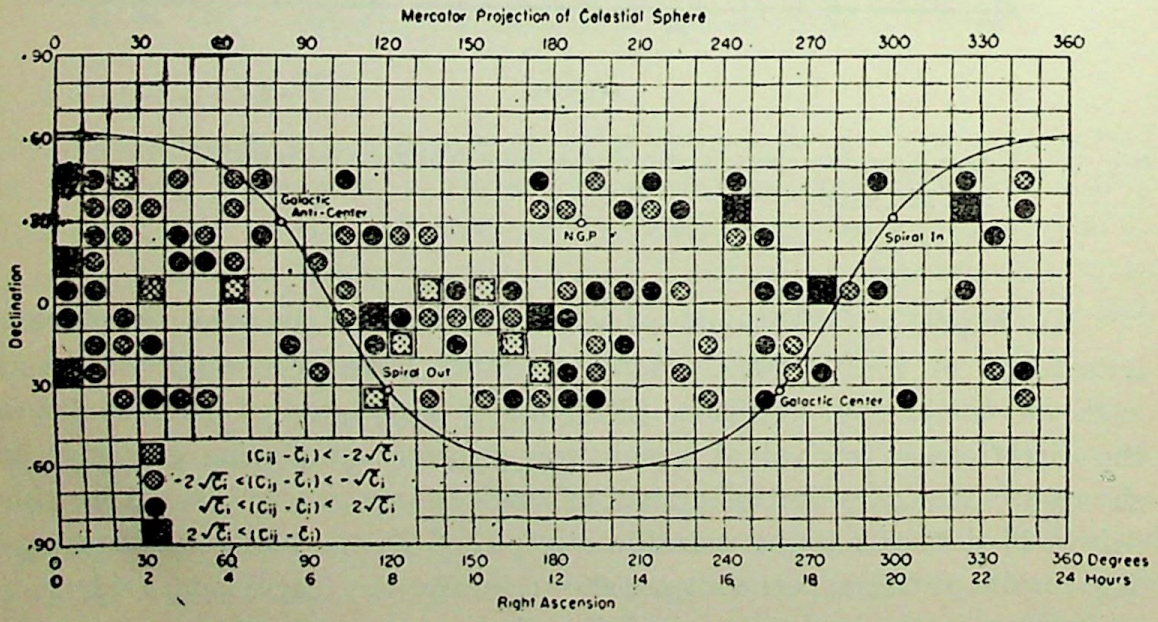


Fig. 3. Fluctuations from declination band averages of intensity of cosmic ray primaries of average energy 10^{15} ev, whose arrival directions are plotted on a mercator projection of the celestial sphere—E. V. Chitnis, V. Sarabhai and George Clark[6].

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The above mentioned results, along with astronomical evidence concerning the size and shape of our galaxy, the density of interstellar gas as well as the orientation of dust particles in magnetic fields, lead to fundamental conclusions concerning the origin of cosmic rays. It would clearly take us away from our subject if I were to go into the details of this fascinating field. The conclusions however are very important to us. Cosmic rays in the energy region $E \geqslant 1-2$ Gev are believed to be mainly of galactic origin. The highest energy cosmic rays of $E \geqslant 10^{17}$ ev may be partly metagalactic. At the low energy end, the sun is known to be a source of cosmic rays; quite frequently emitting particles in the energy range 100–500 Mev, less frequently upto 10 Gev and on rare occasions up to 50 Gev.

We have become aware of the importance of solar cosmic rays relatively recently. It is now understood that the sudden enhancement of ionospheric ionisation over the poles leading to the phenomenon known as 'Polar Cap Absorption', the sudden increase of intensity of protons observed at high latitudes in the stratosphere and the sharp increase observed in neutron monitors from time to time are all evidences of the arrival on earth of solar protons of energy greater than 100 Mev, following the occurrence of certain types of flares generally accompanied by type IV radio emission. Fig. 4

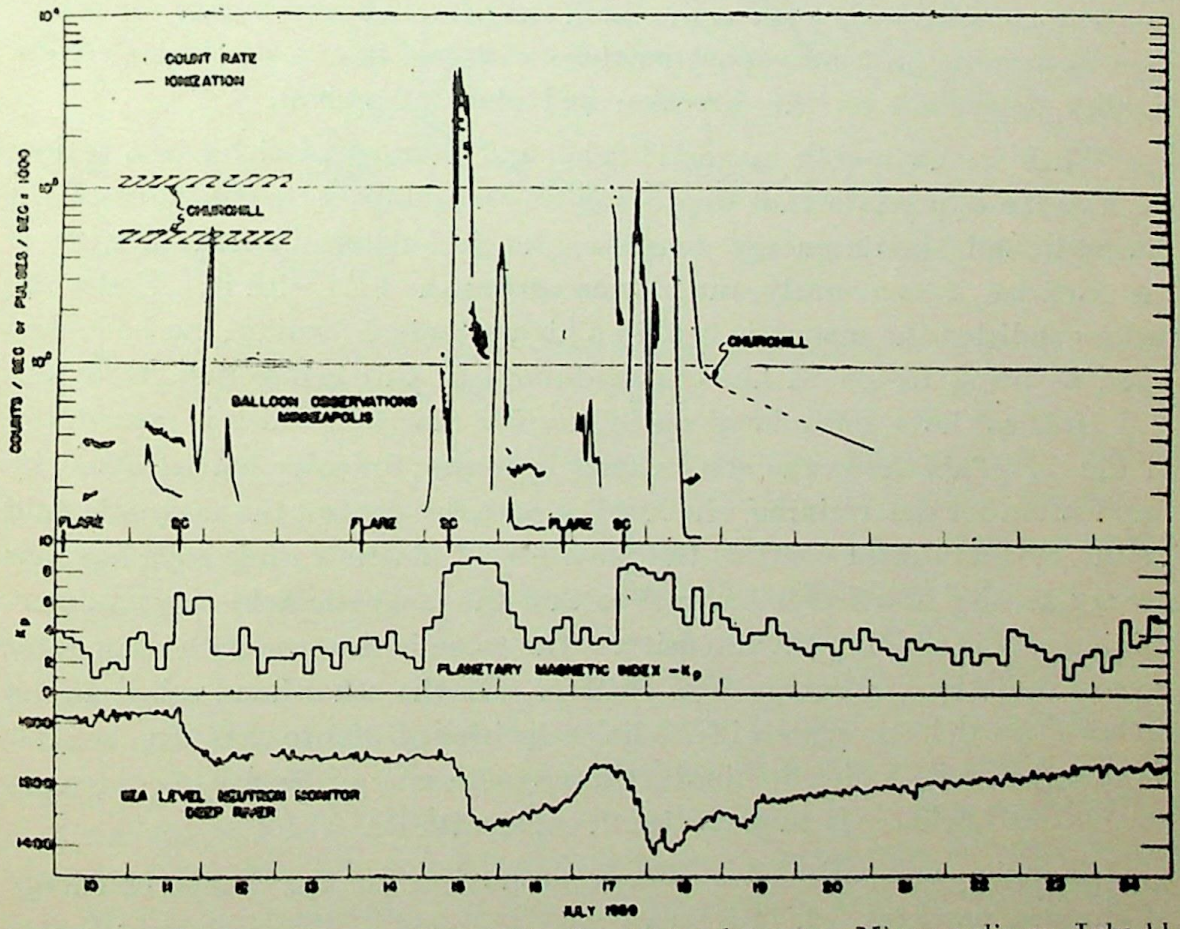


Fig. 4. Solar flare protons observed in the stratosphere over Minneapolis on July 11, 15 and 17, 1959 and by the neutron monitor at Deep River on July 17— J. R. Winckler, P. D. Bhavsar and L. Peterson[7].

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from a study by Winckler, Bhavsar and Peterson[7] shows the enhancement of intensity due to soft solar cosmic rays at Deep River at geomagnetic latitude 60.5° and even at the latitude of 58.1° in the stratosphere when the geomagnetic cut-off was temporarily reduced following the onset of a magnetic storm. The spectrum of solar cosmic rays is much steeper than the spectrum of galactic radiation. Indeed on some occasions and at certain energies, the flux of solar cosmic rays exceeds by many factors the galactic cosmic ray intensity.

3. Cosmic rays as probes of interplanetary electro-magnetic conditions

For deriving information about the sun and interplanetary space we are concerned mainly with cosmic rays in the energy range 0.5 to 100 Gev. We should at the outset appreciate some fundamental aspects of the interaction of charged particles with electric and magnetic fields.

Let us first note that a stationery magnetic field changes only the direction of momentum but not the energy of a charged particle since the force on the particle is always perpendicular to its motion. Nevertheless a magnetised body such as the earth can act as a spectrometer for cosmic rays by turning back into space particles with less than a particular critical rigidity dependent on the direction and place of arrival.

When we have both magnetic fields and charged particles in a region, we have to appreciate that depending on the relative magnitudes of the magnetic and kinetic energy densities, the field determines the motion of the particles or, conversely, the plasma carries the field with it. Under the latter condition the magnetic field in a highly ionised medium can be looked upon as being frozen within the medium. In this connection, Obayashi and Hakura[8] have formulated an interesting diagram, which is reproduced in Fig. 5. This shows the steep energy spectrum for solar particles and its implication for determining whether the particles control the magnetic field or the magnetic field controls the particles. Galactic cosmic rays have an energy density of about 0.5 ev/cm^3 so that the magnetic field plays a determining role in guiding the intensity. The same is the case with most solar proton radiations of energy $E > 10$ Mev. On the other hand solar plasma of lower particle energies with radial velocities of 300 to 2000 Km/sec has an energy density which dominates the magnetic energy density of commonly encountered fields. It then carries the field with it.

Changing magnetic fields offer a mechanism for the change of energy of charged particles, which interact with the field. Alfven showed that a magnetic field frozen in a moving plasma can produce change of energy of cosmic rays traversing through it. This is equivalent to the effect of an

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electric polarisation field across the boundaries of the plasma as observed from the earth with respect to which the plasma is moving. Moreover, through the mechansim proposed by Fermi, the kinetic energy of moving plasma clouds can be transferred to high energy particles which are guided by the magnetic fields frozen in the clouds.

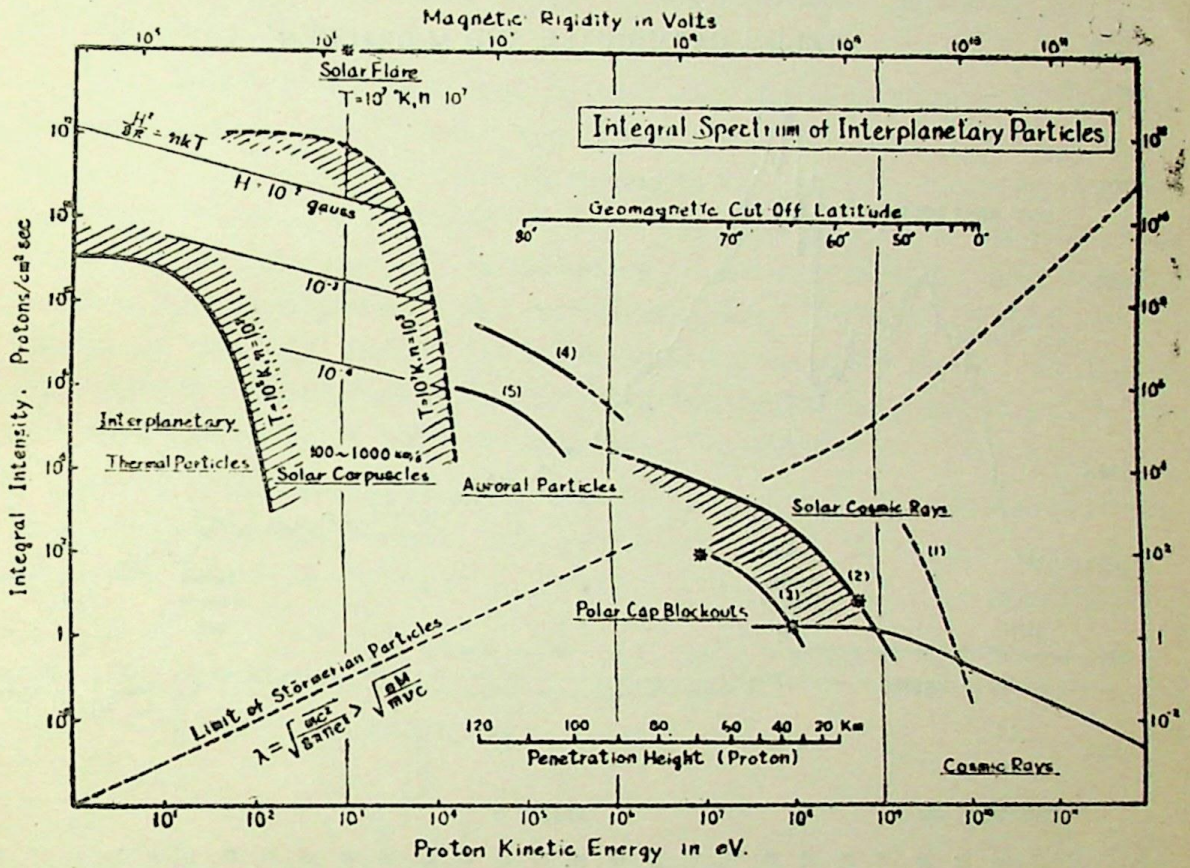


Fig. 5. The integral energy spectrum of solar particles associated with intense solar flares—T. Obayashi and H. Hakura[8].

With solar cosmic rays we derive information on the magnetic fields in interplanetary space by studying the directions of arrival and the isotropy of the radiation. We can also observe solar cosmic rays which are trapped by magnetic fields carried outwards from the sun by plasma clouds. An example of this is seen in Fig. 6 (Steljes, Carmichael and McCracken[9]). The maximum in neutron intensity at Deep River at 1600 U.T. on the 12th of November 1960 was due to solar cosmic rays produced in a large flare which started at 1320 U.T. No corresponding increase was seen in the intensity of mesons at MIT. However, a second increase of neutron intensity commenced at 1900 U.T. coincident with the occurrence of a Forbush decrease in MIT meson intensity. It has been interpreted that the cosmic ray flux in space increased at 1900 U.T. when a plasma cloud from the sun entailing magnetic fields and trapped solar particles enveloped the earth, producing a Forbush decrease.

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With galactic intensity, we can look for changes of isotropy and of spectrum that arise from the movement of coherent or turbulent magnetic fields associated with the movement outward from the sun of plasma wind or streams or clouds or shock waves. We can then follow the magnetic field configuration as well as the movement of plasma and examine associated earth-sun relationships.

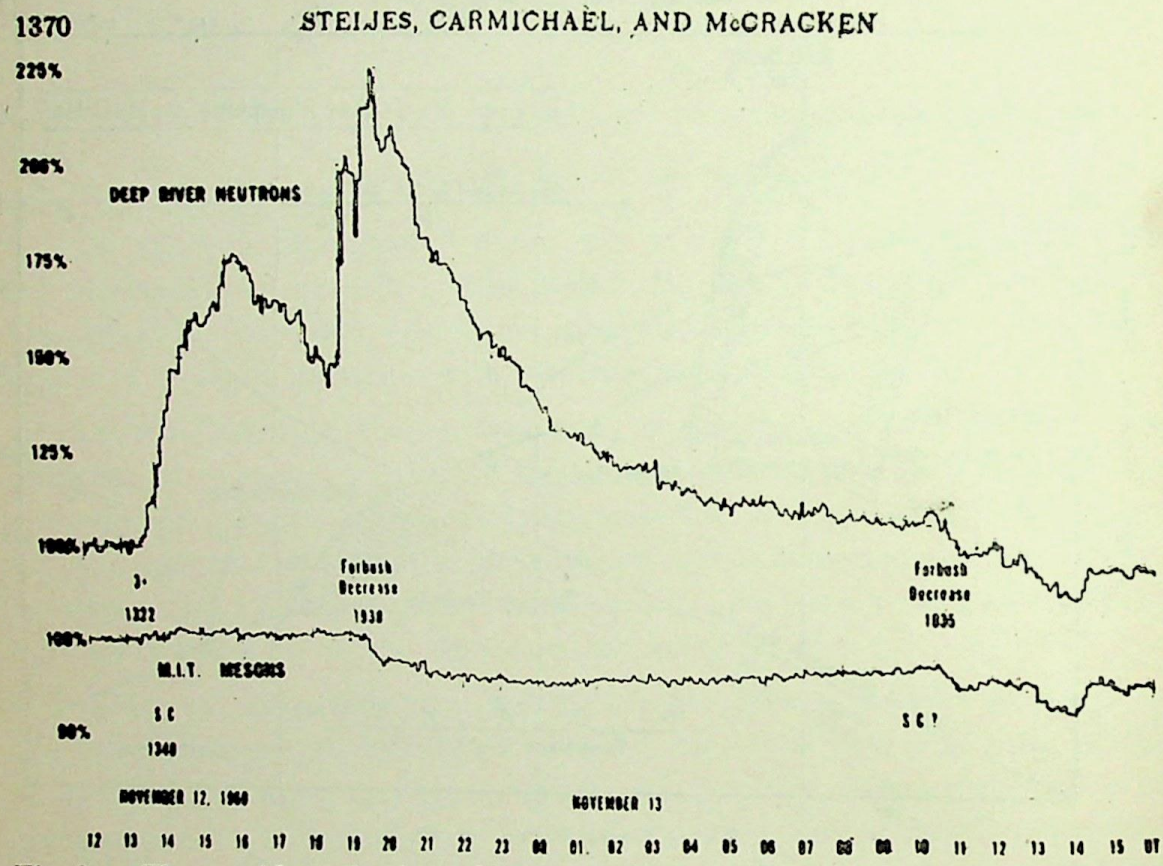


Fig. 6. The concidence in time of increase of Deep River neutrons and the Forbush decrease of *MIT* mesons beginning 1900 U.T. on November 12, 1960— J.F. Steljes, H. Carmichael and K. G. McCracken[9].

The sun and interplanetary space thus provide us with a laboratory on a grand scale for studying phenomena under conditions which we do not hope to reproduce in the foreseeable future. And of the particle radiations which could be influenced by interplanetary electromagnetic conditions, cosmic rays are perhaps the most convenient to study with accuracy from the surface of the earth and their variations interpreted in a relatively unambiguous manner. This is reflected in the importance attached to global investigations of cosmic ray time variations during the IGY and the proposed International Year of the Quiet Sun.

4. Global studies of cosmic ray time variations

I have remarked earlier that the earth with its magnetic field acts as a spectrometer for cosmic rays. Those who are familiar with the development of our understanding of the geomagnetic effects on charged particles

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incident from outside will recall that this subject received early attention from Brikland and Störmer, who tried to explain aurora. Störmer calculated orbits of particles in the geomagnetic field using numerical methods. But since galactic cosmic ray intensity is substantially isotropic in character, Lemaitre and Vallarta were able to simplify the problem, by reducing it to one involving the calculation of allowed and forbidden regions for particles of different rigidities.

The discovery of solar cosmic rays and the importance of studying transient anisotropies of solar and galactic cosmic rays have once again brought to the fore the need of calculating individual particle orbits and the asymptotic cones of acceptance of cosmic ray instruments at different parts of the world. Moreover, it is necessary to take account of higher order terms in the description of the real geomagnetic field and of the perturbations of the field due to causes external to the solid earth. Therefore several studies of particle trajectories involving modern high speed computers and analogue methods have recently been undertaken.

Fig. 7 from a recent study by McCracken for radiation with a spectrum characteristic of solar cosmic rays, brings out clearly the significance of experiments made at different locations. Very close to the geomagnetic

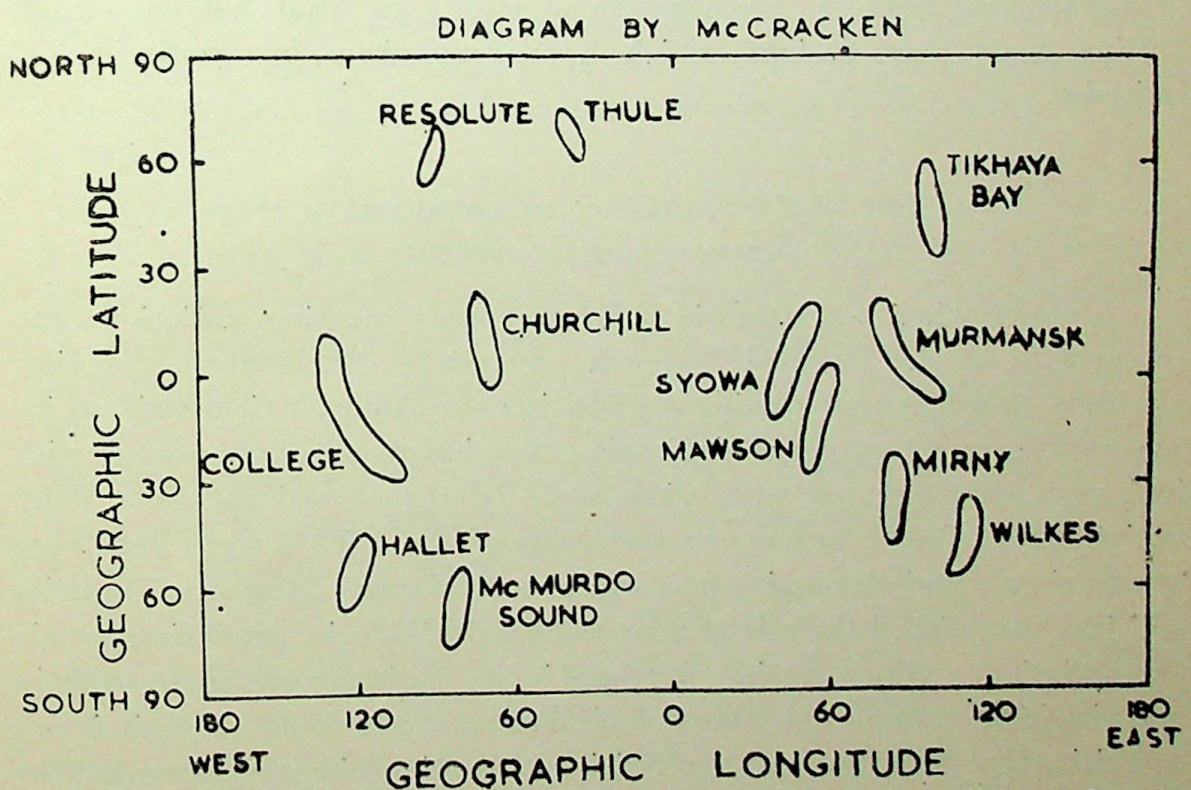


Fig. 7. Asymptotic cones of acceptance of neutron monitors at different locations for solar flare cosmic rays—Diagram by K. G. McCracken.

poles, cosmic ray telescopes look at a specific direction in space almost perpendicular to the plane of the ecliptic. Near the geomagnetic equator, cosmic ray telescopes look at intensity incident along the plane of the ecliptic

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and scan the meridians of the celestial sphere as the earth spins on its axis. At intermediate latitudes, the spatial response of cosmic ray telescopes is sensitively dependent on the energy spectrum of the incident radiation and the energy response of the detector.

At low levels in the atmosphere, neutron monitors which measure secondaries produced through a nucleonic cascade have an average energy response for primaries which is lower than the energy response for a mu-meson detector at the same location. For example, for a station at geomagnetic latitude 50° the mean response of a neutron monitor is about 11 Gev while for a mu-meson detector it is about 43 Gev. Since low energy primaries are deflected in the geomagnetic field more than high energy primaries, the spatial response of a neutron monitor is subject to more drastic changes with energy spectrum than of a mu-meson detector.

For solar cosmic rays which are rich in low energy particles, it is most appropriate to make measurements at high latitudes and near the geomagnetic poles. On the other hand, the modulation of galactic cosmic rays involves plasma moving outwards from the sun and therefore cosmic ray primaries incident along the plane of the ecliptic are of special significance. For this reason, it is particularly valuable to measure time variations of cosmic rays near the geomagnetic equator. In what follows I shall outline some new insights which have come from our work at low latitudes.

5. The daily variation of cosmic rays and meteorological effects

In 1948, when a systematic study of cosmic ray time variations was commenced at the Physical Research Laboratory, Ahmedabad, the view generally held amongst cosmic ray physicists was that galactic cosmic ray intensity was almost completely isotropic. Experiments were made largely with ionisation chambers or with wide angle telescopes and the solar daily variation was found to have an amplitude of about 0.2% when data were averaged over periods ranging from one to several years. Moreover, Duperier had just established the role of meteorological effects in producing cosmic ray variations. Since the time averaged daily variation was comparable in magnitude to some of the meteorological effects that could arise, it is not surprising that many cosmic ray physicists at the time did not believe that the observed solar daily variations could be associated with a solar anisotropy of primary cosmic rays. I felt differently for reasons which I will explain.

When I was conducting an experiment at Bangalore in 1944, on the low energy mu-meson component in the atmosphere, I became conscious of the large magnitude and regularity of the daily variation of cosmic rays which,

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at first sight, appeared to be related to the barometric pressure. Meteorological effects at an equatorial station are generally rather different from those at middle or high latitudes, where day to day changes of pressure are relatively more important than the daily variation. At Bangalore one could almost set one's clock by the phase of the semi-diurnal variation of barometric pressure occurring day after day. I looked for a relationship between this and the semidiurnal variation of mu-meson intensity. To my great surprise, I found that there was a positive correlation between the two in place of the usual negative effect which one would expect from an increase of mass absorption and a raising of the level of mu-meson formation in the atmosphere with an increase of pressure.

Three years earlier, but unknown to me because of the war, Rau had reported a similar result from observations made under 40 meters of water at Lake Constance in Germany. We were both led to a qualitative explanation invoking a consequence of the theory of atmospheric oscillations which requires a reversal of the phase of the semi-diurnal barometric oscillation above the 30 Km level in the atmosphere. It was argued that if the mean level of meson formation occurred above 30 Km, the survival probability of the unstable mu-meson would increase rather than decrease at a time at which ground level barometric pressure has a semidiurnal maximum. However, in 1947, when Nicolson and I[10] attempted at Cambridge to calculate the precise implications of this interpretation it became clear that the observed positive correlation could not be explained in any well understood way by the known daily variation of conditions in the atmosphere.

A little later, directional studies in East-West and North-South azimuths made by Malmfors[11] and by Elliot and Dolbear[12] showed that even though common meteorological effects were acting, the pattern of the daily variation was not the same in the different directions. Thus it was concluded that at least a part of the observed variation was non-meteorological in origin. Moreover, the pattern of daily variation in East and West pointing telescopes had a phase shift which indicated that the variation was related to a solar anisotropy which was being scanned by the telescopes fixed to the spinning earth.

Today, in deriving information about the anisotropy of the primary radiation from the daily variation of meson intensity, the importance of applying corrections for the daily variations of barometric pressure and of atmospheric temperature at different levels is realised. Much progress has been possible in recent years through theoretical and experimental work by a number of workers. Duggal[13] has suggested a method which uses ground temperature and the altitude dependence of the daily variation of temperature derived by meteorologists. This appears to provide a good

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approximation of the true correction which generally is estimated to be under 0.2% in amplitude. I wish to acknowledge here the very valuable help we have received from Professor K. R. Ramanathan in this problem.

6. The study of time variations and anisotropy of primary radiation at low latitudes.

In starting a programme in India to observe the solar anisotropy of primary cosmic rays, we felt that it was necessary to develop an optimum experimental arrangement. In 1947 we did not have available to us studies on the geomagnetic deflections of cosmic ray primaries or on scattering of secondaries in the atmosphere, but it seemed that a very wide angle telescope or an ion chamber may not provide the best geometrical arrangement for studying the variation of intensity as the anisotropy is scanned. We, therefore, started with an instrument involving 4 vertical meson telescopes with 22° semi-angle of opening in the East-West plane and 37° semi-angle of opening in the North-South plane. This instrument, which is known in our group as the "Standard" counter telescope, has been installed at 3 stations northwards of the geomagnetic equator along the 75°E meridian through India.

Data are now available of the daily variation of meson intensity in the vertical direction, at Ahmedabad from 1951, at Kodaikanal from 1952 and at Trivandrum from 1955. The neutron monitor developed by Simpson was also later set up at Ahmedabad, Kodaikanal and Gulmarg for the IGY programme. Fig. 8 shows the locations of our instruments and the coverage they provide in terms of the primary galactic spectrum.

One of the first results from our standard units was the discovery of a long term change in the form of the daily variation. We could observe the change from year to year with diminishing solar activity approaching 1954 and we sought confirmation in the much longer series of observations with the ion chamber at Huancayo for which data from 1938 to 1943 were furnished by Forbush and Lange. In 1953, Kane and I[14] published the results of an analysis which are reproduced in Fig. 9. We showed for the first time that the diurnal component undergoes significant changes with a period of 11 years broadly in step with the cycle of solar activity. The changes occurred in amplitude as well as time of maximum and the world-wide character of the latter was most striking. Almost simultaneously and independently of us, Thambyahpillai and Elliot[15] reported results concerning the world-wide change of time of maximum of the diurnal component and made the important observation that there was possibly a 22 year period. Desai, Venkatesan and I[16] later confirmed this and demonstrated the close correspondence of changes of diurnal time of maximum and the intensity of the 5303°*A* green coronal emission from the sun.

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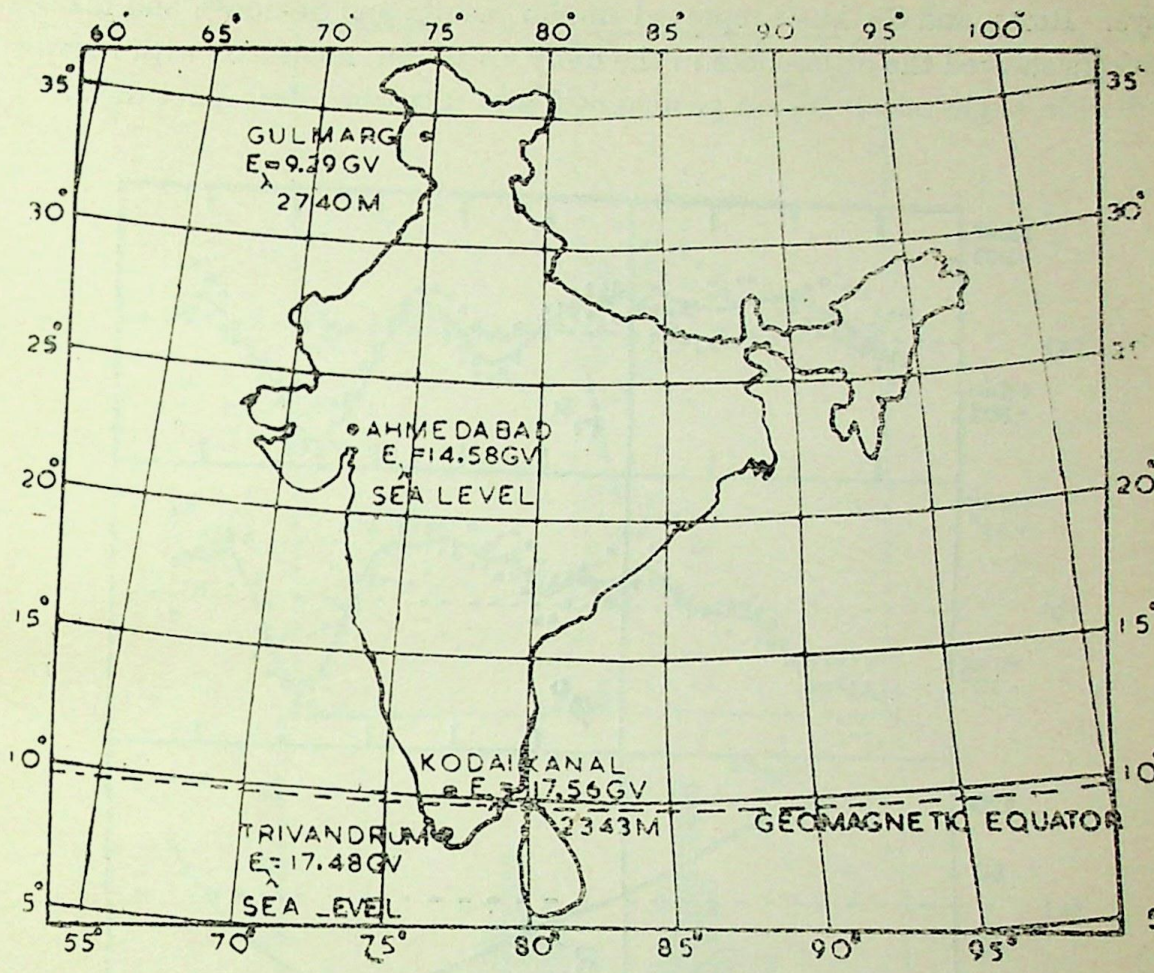


Fig. 8. Locations of Indian cosmic ray stations operated by the Physical Research Laboratory. The elevation of each station and the critical cut-off rigidity (Quenby and Webber) are indicated.

Comparison of our results obtained with counter telescopes and those from ionisation chambers demonstrated that the amplitude of the daily variation as well as its changes were seen very much more clearly with counter telescopes than with omnidirectional detectors. In an attempt, therefore, to push to a limit the technique of narrow angle telescopes, Bhavsar, Nerurkar and I[17] conducted experiments in 1954 with telescopes of different angles of opening in the E–W plane. This work immediately proved rewarding by showing that a high amplitude of daily variation was recorded with a reduction of the angle of opening. Moreover when the daily variation of intensity measured with narrow angle telescopes on each day was harmonically analysed, we found as shown in Fig. 10 that there were in 1954 two preferred hours of the time of maximum of the diurnal component. Thus the changes of the daily variation and of solar anisotropy were indeed present on a day to day basis as well as for the period of the solar cycle. This view was confirmed by other studies conducted about the same time. Firor *et al.*[18] reported that the daily variation observed with neutron monitors was very variable and occurred with a particular form on groups of

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days. Remy and Sittkus[19] reported similar results and Sekido[20] and his co-workers showed the differences in the daily variation measured with narrow and wide angle telescopes on geomagnetically disturbed and quiet days.

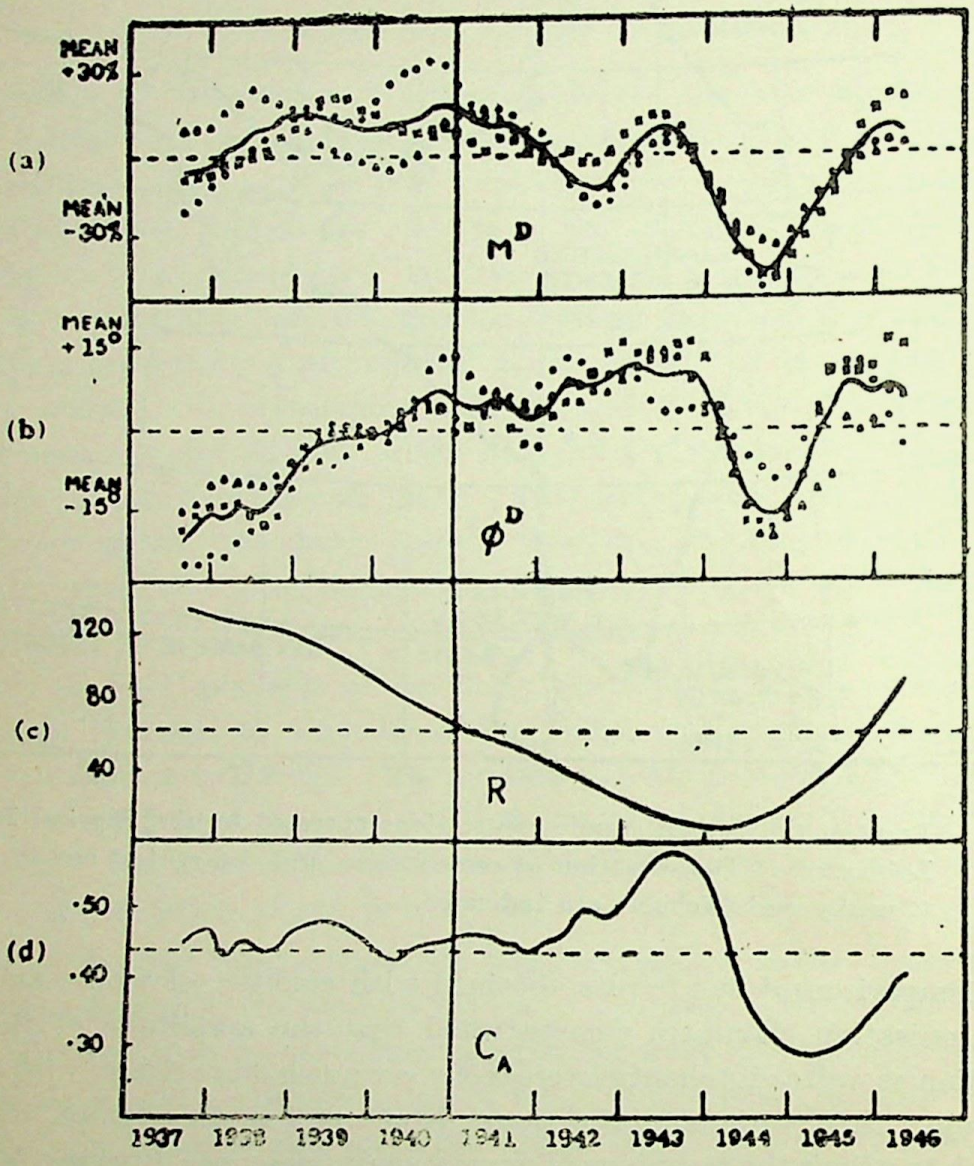


Fig. 9. 11 year cycle of change of the diurnal component of the solar daily variation of cosmic rays. This is seen from time-series for annual mean values during period 1937-1946 of (a) M^D meson diurnal amplitude ; (b) ϕ^D meson diurnal hour of maximum ; (c) R Zurich sunspot number ; (d) C_A American magnetic character figure. The results from individual stations are indicated by ▲ for Huancayo, × for Cheltenham, and ● for Christchurch.—V. Sarabhai and R. P. Kane[14].

By 1955 our own results and those obtained in other laboratories brought home the realisation that in the daily variation we were indeed observing some important property of primary cosmic rays which was controlled by the electromagnetic condition of interplanetary space. One could conclude that :—

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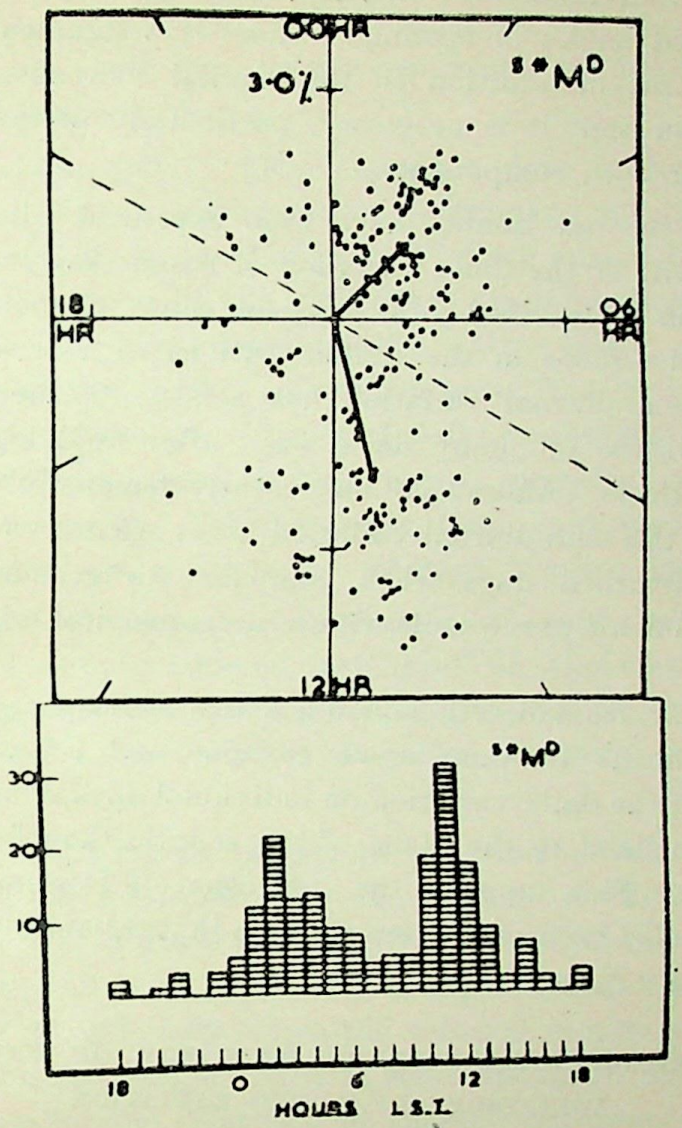


Fig. 10. (a) 24 hourly harmonic dial showing diurnal component on each day for a 5° narrow angle telescope.

(b) Histogram of occurrence of diurnal maximum for each of 24 hours of the day.

V Sarabhai and N. W. Nerurkar[17].

(a) The solar daily variation undergoes significant changes from year to year and from day to day. In consequence, time averages of data over an extended period can be quite misleading as regards the magnitude and sometimes even as regards the direction of the anisotropy.

b) The solar daily variation is often observed better with telescopes of moderate angles of opening than with wide angle instruments. Its amplitude is as large as 1% on some days and can be about 0.5 to 0.6% even when averaged over a year.

c) In view of the variability of the anisotropy, the optimum technique for observing it should involve the study of the solar daily varia-

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tion on individual days with high counting rate instruments having restricted angles of opening. There is a significant semi-diurnal component in addition to the diurnal component in the daily variation and it is necessary, particularly at low latitudes, to consider both components.

From time to time doubts have been expressed whether the semi-diurnal component of the daily variation of cosmic ray intensity even at low latitudes can be ascribed to a physical cause of non-meteorological origin. In studies made at the Indian stations with meson and neutron intensity, the semi-diurnal variation has persistently been present with significant amplitude on many days, even after applying correction for meteorological effects. Ahluwalia[21] has recently demonstrated that the time of maximum of the semi-diurnal variation has a greater variability on geomagnetically disturbed days when compared to geomagnetically quiet days. This is difficult to reconcile with a meteorological origin of the variation.

Very recently, from directional studies with telescopes pointing to North and South azimuths at Ahmedabad, Gottlieb and I[22] have shown that the amplitude of the daily variation on individual days is smaller for cosmic ray primaries inclined to the plane of the ecliptic than for those arriving along the plane. This supports the conclusion of Dorman[23] and recently of Sandstrom *et al.*[24] from time averaged data that the anisotropy is strongest along the plane of the ecliptic.

7. Correlated changes of energy spectrum, of intensity and of anisotropy of cosmic radiation

We have seen examples in Figures 1, 2 and 9 of long term changes of energy spectrum, of intensity and the direction of anisotropy of cosmic radiation. These changes are related to the cycle of solar activity. Similar associated changes can be expected during other kinds of time variations of cosmic rays except when special types of processes of modulation are operative. For several years, therefore, it has been an important objective of our programme to seek relationships between these changes during cosmic ray storms and during variations of smaller magnitude which often have a 27 day recurrence tendency. We have been interested in the question whether the day to day changes of intensity are always decreases or decreases as well as increases with respect to the galactic intensity at the appropriate period of the solar cycle. We have moreover wanted to know the relationship of the changes with solar and geomagnetic activity.

In looking at data on a day to day basis, we were confronted with an appreciable level of back-ground noise, and a daily variation which contained on many days both a diurnal and a semi-diurnal component almost

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to an equal degree. We therefore required a method of analysis which could take account of the daily variation unresolved into its harmonic components and could show up the real cosmic ray effects at an adequate level of statistical significance.

Satyaprakash and I[25] have examined data from a neutron monitor at Kodaikanal through histograms of positive and negative bi-hourly deviations of intensity (from the day's mean), which exceed the 2σ level of significance. The pattern of the histograms clearly indicates the association of individual bi-hourly deviations with a true daily variation. This has shown on a marginal level of significance, like the earlier work with Bhavsar[26], that there are 2 types of daily variations, one which can be associated with increase of daily mean intensity and another with decrease of intensity. This has since been confirmed more rigorously with Ahluwalia[27] using Huancayo neutron monitor data.

The most convincing demonstration of correlated changes however comes from a study conducted with Rao[28] at Ahmedabad using East and West pointing telescopes inclined at 45° to the zenith. The experiment clarifies three important aspects of the day to day modulation of galactic cosmic rays.

a) By comparing the pattern of variation exhibited by East and West pointing telescopes, one can determine whether the modulation occurs at a great distance (when the changes in east precede the changes in west by about 6 hours) or whether it takes place within 1 or 2 earth radii (when the patterns almost coincide in time).

b) When the modulation is at some distance from the earth, one can allow for the deflection of charged primaries in the geomagnetic field and determine the position of the source of modulation with respect to the earth-sun line.

c) Since the geomagnetic cut-off in east is greater than the geomagnetic cut-off in west (at the geomagnetic equator in India the cut-offs for east and west are 23.1 and 11.2 Gev respectively), one can make a two point determination of the energy spectrum of variation of the primaries from the east-west asymmetry on each day.

Using this simple, but powerful tool, we have got some interesting results. Fig. 11 shows on a polar histogram that during 1957-58 there were many days when the daily variation at Ahmedabad was consistent with an anisotropy of primary radiation. The source of anisotropy was situated on the average at an angle of 112° to the west of the earth-sun line. However, there were a significant number of days when the daily variation appears to have been caused by a local source of non-meteorological origin in the direction of the sun.

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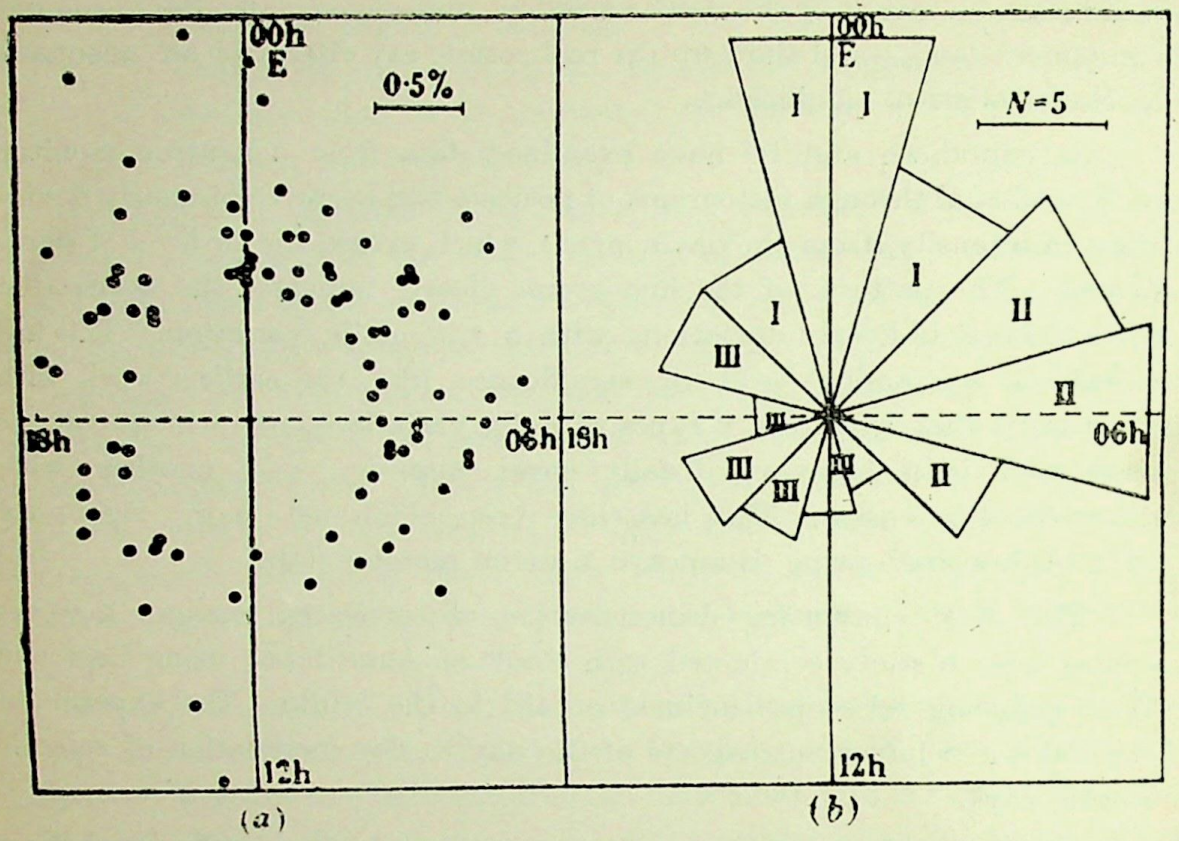


Fig. 11. (a) The distribution of diurnal component of daily variation for west relative to that for east, assumed to be along 00.00 *h* direction, on individual days when the amplitudes of variation for east and west are simultaneously significant at the 2σ level.

(b) Harmonic dial representation of the histogram of occurrence of the diurnal maximum for west relative to that for east, assumed to be along the 00.00 *h* direction, on individual days when both east and west have significant amplitudes. U. R. Rao and V. Sarabhai[28].

Fig. 12 shows the changes of intensity which are associated with a steepening of the spectrum (high East-West asymmetry) and with a flattening of the spectrum (low East-West asymmetry). The relationship between changes of spectrum, intensity and geomagnetic field is clearly brought out in the diagram. Low asymmetry epochs occur generally 3 to 5 days after the onset of cosmic ray storms associated with SC magnetic storms. On other hand, high East-West asymmetry occurs when geomagnetic conditions are relatively undisturbed and 3 to 5 days before geomagnetic disturbances set in. The relationship of the two types of daily riation observed by us is summarised in Table 2.

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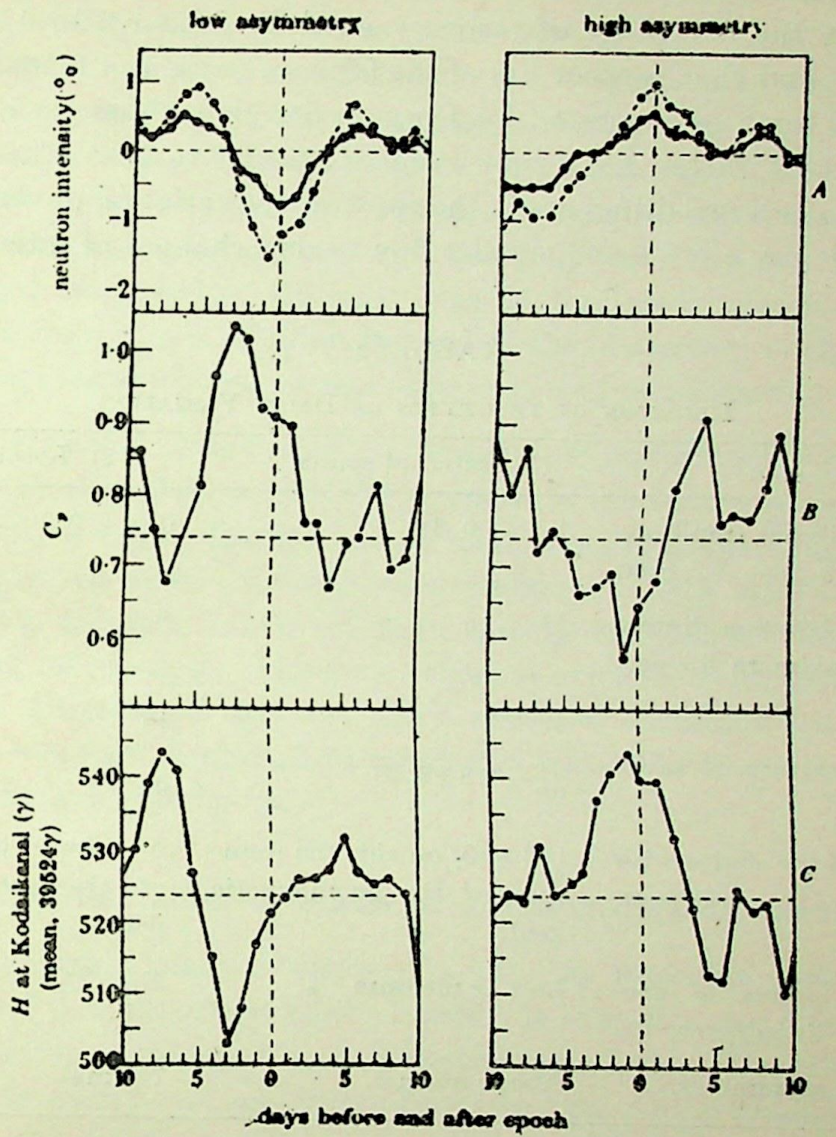


Fig. 12. The Chree analysis for epochs corresponding to days of low and high east-west asymmetry of (A) daily mean neutron intensity at stations situated in equatorial (——) and middle latitude belts (...), (B) C_p and (C) H, the daily mean intensity of the horizontal component of the geomagnetic field at Kodaikanal.
U. R. Rao and V. Sarabhai[28].

In the past, many investigators have used the latitude effect of a cosmic ray intensity variation to determine its energy spectrum. This procedure is valid only if the modulating mechanism produces the change of intensity isotropically. In a recent study of large cosmic ray storms, Pai, Rao and I[29] have demonstrated that the modulating mechanism has an anisotropy perpendicular to the ecliptic during the onset of the storms and during the

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late stage of recovery of intensity. The modulation however occurs isotropically in the first stage of recovery extending from 2 to 5 days after onset. We find that a spectrum of the form $a\epsilon^{\circ}$ with $a = 0$ for $E \geqslant E_{max}$ ($\approx$40 to 60 Gev), as suggested by Dorman fits global changes better than a spectrum $a\epsilon^{-x}$ where x has a value ranging from 0.7 to 1.0. There appears, therefore, to be a real difference in the spectrum of variation produced during large cosmic ray storms and smaller day to day changes of intensity.

TABLE 2

RELATION OF TWO TYPES OF DAILY VARIATION

	(1) External source	(2) Local source
Ratio of diurnal amplitude for west to that for east.	1.5 ± 0.3	0.8 ± 0.1
Difference between diurnal time of maximum for east and west.	$6h$	0
Energy spectrum of variation.	$a\varepsilon^{-0.8\pm0.3}$	$a\varepsilon^{\circ}$
Location of the source with respect to the earth-sun line.	$112\pm10^{\circ}$ outside the influence of the geomagnetic field.	0° within the influence of the geomagnetic field.
Associated index of geomagnetic disturbance C_p.	Low or medium C_p	High C_p
East-West asymmetry.	Above normal.	Normal.

We moreover find that during a major storm, plasma is ejected or a shock front travels outwards over a wide cone such that it changes magnetic fields in a substantial part of interplanetary space. This is in conformity with recent evidence from space probes concerning cosmic ray decreases at great distances from the earth (Fan *et al.*[30]).

8. SOLAR AND TERRESTRIAL RELATIONSHIPS OF CHANGES OF COSMIC RAY ANISOTROPY

A major experimental difficulty in studying the anisotropy of cosmic radiation through the daily variation during cosmic ray or geomagnetic storms lies in separating local time changes from universal time changes of intensity. Many workers have reported interesting relationships between the changes of daily variation and geomagnetic disturbances. In general, an enhanced amplitude and an earlier time of maximum of the diurnal component have been reported during days which are geomagnetically

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disturbed. Sastry[31], Duggal[13a], Satyaprakash[25] Ahluwalia[32] and Razdan[33] have sought confirmation of the reported relationship from studies made in India. Kane[34] has attempted the same task using a more rigorous technique, first suggested by Sekido and his-workers, which involves the use of data from 3 comparable stations situated meridianally 120° apart. No clear cut one to one relationship between the magnitude of the planetary index of geomagnetic disturbance and the daily variation can be seen in data collected since 1955. However, the 27 day recurrence tendency of many cosmic ray changes of intensity and of the occurrence of daily variation with large amplitude on groups of days is well established.

An experimental observation of considerable importance concerns the change through the solar cycle of the strength of the source of daily variation on individual days. Razdan and I[35] have recently shown that the daily variation measured with wide angle instruments on individual days is no smaller during sun-spot minimum than during the periods immediately preceding and following it. Moreover, there is evidence from narrow angle telescopes at Ahmedabad that the daily variation on individual days decreases from sun-spot minimum to maximum while the direction of anisotropy also changes significantly.

9. ELECTROMAGNETIC STATE ON INTER-PLANETARY SPACE

I have described many features of cosmic ray intensity variations and anisotropy and it is important before I conclude to summarise what we have gained from the interpretation of these cosmic ray effects. The 11 year cycle of change of intensity and spectrum of cosmic rays, and preliminary results dealing with the gradient of this change in the solar system indicate that the main modulation takes place in a heliocentric barrier situated beyond 1 A.U. from the sun. Cosmic ray storms involve wide regions of interplanetary space and appear to be related to the screening of galactic cosmic rays by a big bubble of plasma or by a shock front in an existing plasma wind as described by Parker[36]. When the bubble or shock front has passed beyond the distance of the earth, we get a strengthening of the heliocentric barrier. The directions of arrival of solar cosmic rays have shown that in general there is connection between the earth and the sun through guiding magnetic lines of force. Some times a shock front or bubble of plasma can itself carry with it trapped solar particles.

For the interpretation of the anisotropy and its correlated changes, we have the model of Alfven, which has been treated in its most elaborate form by Dorman.[23] As has been recently demonstrated by Rao and I[28], increases in east-west asymmetry and the associated daily variation for east and west directions can be fairly well explained by the acceleration of cosmic

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ray particles crossing beams of solar plasma in the neighbourhood of the earth. For beams of width 5×10^{12} cm with a frozen magnetic field of the order of $10^{-4}G$, a radial velocity of about 1.5×10^{8} cm/s is required. The process is possible only if the ejection of beams takes place in rarefied regions of interplanetary space which extend radially over active solar regions. The change of the amplitude of the daily variation from solar minimum to maximum proceeds in the correct direction when one considers the average plasma density that may be expected in interplanetary space at the two periods. A reversal of the component of the frozen magnetic field perpendicular to the plane of the ecliptic provides a means for a major change of direction of the anisotropy as was suggested by Nerurkar.[37]

An alternative interpretation of the daily variation which is attractive has come recently from Ahluwalia and Dessler.[38] This involves a helical co-rotating solar magnetic field stretched by a radially moving solar plasma wind. The change of intensity of cosmic rays and the amplitude of the daily variation can be related to the radial velocity of the plasma wind and the intensity of the magnetic field. The values of these parameters required to explain a diurnal variation of about 0.5 to 0.8% appear plausible and the time of maximum agrees with observation at many periods of the solar cycle. However the full implications of this interpretation have still to be examined.

Perhaps the true picture of interplanetary conditions involves regions with different radial velocity of plasma extending over different meridianal sections of the sun. There would be some regions where this velocity would be quite small. Local magnetic fields could also prevent the outward flow of plasma. Over these regions, there would occasionally be a major outburst of plasma carrying frozen magnetic fields and a regime of the type described by Dorman.

10. Conclusion

It would be misleading if I were to convey that the broad picture indicated in the previous section is at this stage anything more than a tentative piecing together of diverse facts, some of which have still to be well established. The lacuna arises from several factors :—

a) Rather imperfect coverage of cosmic ray stations on the globe.

b) Insufficient counting rates of instruments measuring intensity changes.

c) Dearth of studies of time variations of directional mu-meson intensity at low latitudes.

It is expected that these shortcomings will be at least partially corrected before the forthcoming International Year of the Quiet Sun. An experiment is now being conducted at MIT with a mu-meson detector, having a counting

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rate of 1000 per second. It is hoped shortly to study the time variations of a large scintillator array at Chacaltaya in Bolivia, with a counting rate of 30,000 mu-mesons per second. It should therefore soon be possible to determine with accuracy the direction and magnitude of the solar anisotropy of cosmic rays on each day. It is, I believe, realistic to expect that cosmic rays will in time provide the most effective means for the regular sounding of interplanetary electromagnetic conditions.

In conclusion, I wish to express my gratitude to Professor K. R. Ramanathan and to my collaborators at the Physical Research Laboratory, Ahmedabad, and at the Massachusetts Institute of Technology, Cambridge. In particular, I should mention R. P. Kane, U. D. Desai, D. Venkatesan, N. W. Nerurkar, P. D. Bhavsar, Satyaprakash, E. V. Chitnis, George Clark, R. Palmeira, T. S. G. Sastry, S. P. Duggal, U. R. Rao, H. S. Ahluwalia, H. Razdan, G. L. Pai and B. Gottlieb. I also wish to acknowledge my deep gratitude to the Department of Atomic Energy of the Government of India for generous support to our work.

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SECTION OF CHEMISTRY

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PRESIDENTIAL ADDRESS

ELECTROCHEMISTRY OF EXTENDED STRUCTURES.

I am thankful to the authorities of the Indian Science Congress Association for the honour they have done me by electing me President of the Section of Chemistry of this Session of the Congress. I take this opportunity to say a few words on a branch of chemistry in which I and my colleagues in the University of Delhi have been interested for some time past.

Chemistry took a new turn with the discovery of ions and a large organised body of chemical knowledge, which has come to be known as electrochemistry, has grown over the years through studies of chemical equilibria and rate processes where ions as such play a distinct, if not, major role. Electrochemical phenomena are spread over a wide field and many striking advances in several areas of electrochemistry have been made in the past few decades. The tempo of progress has never slackened.

As in any other branch of science, progress in electrochemistry has been due, in a large measure, to the discovery of certain unifying principles which have served not only to collate and clarify existing data and information but also to indicate new lines on which further information was to be sought. One of these principles, perhaps the most fundamental of them, related to the nature or, rather, the structure of electrolytes. As is well known, the idea that the strong electrolytes exist in solution only as ions soon served to resolve many of their anomalies. On the assumption that coulombic interactions between the ions into which they dissociate were solely responsible for their non-ideal behaviour and on the further assumption that the ions could be regarded as point charges, Debye and Onsager could deduce limiting laws which correctly reproduced the thermodynamic and conductance behaviour of strong electrolytes at low ionic concentrations. The point-charge approximation for ions completely ignored the part played by their structures. Deviations from the limiting laws based on the point-charge concept appeared as the ionic concentration increased. A much better fit between theory and experiment could be obtained if the ions were regarded as hard spheres with finite diameters. The concept of collision diameters of ions, though primarily introduced to take account of repulsive forces, in a way also recognised the part played by the structure of the electrolyte molecule. However, in the theory as it developed, the collision diameter was only an adjustable parameter whose value depended upon the fit which it gave between theory and experiment. This no doubt detracted from the merit of the collision diameter as a physically significant structural feature of the

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electrolyte molecule. The fact remains, however, that in simple cases, e.g., several 1 : 1-electrolytes, the use of a single value of the collision diameter gives excellent agreement between prediction and observation over a wide range of concentrations. While this agreement is no proof that the collision diameter represents an intrinsic structural feature of the electrolyte molecule, it is no doubt strong indication that the structure or rather the geometry of the molecule plays an important role in determining its electrochemical behaviour.

How complicated can this geometry be? How large can be its influence? Does the geometrical factor operate only as a volume of exclusion, or, has the electrolyte a fine-structure and there are 'site' effects? These questions almost do not arise in the case of simple electrolytes and ions having diameters of a few Angstrom units. It would be enough to regard them as tiny hard spheres and to think of a fine structure of the latter would be oversophistication. The situation could be quite different if, on the other hand, the electrolyte had an extended structure, i.e., if it were, say, a long chain molecule like polyacrylic acid, or, a protein molecule with a long polypeptide chain from which branched out numerous side chains, or, if it were a charged colloidal micelle formed by the aggregation of a number of fatty acid chains, or, as an even more extreme case, if the electrolyte had an infinite space structure as one finds in a cross-linked ion exchanger. In all such cases, the geometrical factor would, evidently, play an important part.

Formulation of the geometrical factor and its precise role is a difficult problem which has been solved only in the simplest cases. A chain molecule linked by C-C bonds and capable of free rotation about these bonds takes an average shape which is given by the method of random flights[1]. The statistics is more involved if rotation about the bonds is hindered due to bond-angle requirements and steric effects[2]. Important statistical distances, e.g., the rms end-to-end distance of the chain, its polar radius of gyration and the radius of the smallest sphere which would envelop the (coiled) chain have been calculated and used in discussions of the optical, elastic and flow properties of the chain.

A new situation arises if free charges are located at several points on the chain. The charges are created by the dissociation of ionisable groups attached to the molecule. The chain molecule is now a linear polyelectrolyte. The charges on the chain would drive its segments apart and cause an overall inflation of the chain. All properties of the chain which are related to its shape would be materially affected. The observed effect will depend on the magnitude of the static charges and their distances apart on the chain. These two structural features, together with environmental factors such as temperature, dielectric constant and the ionic strength of the medium, will determine the behaviour of the polyelectrolyte.

As with ordinary electrolytes, the problem of formulating polyelectrolytic behaviour is, basically, one of calculating the electrostatic potential and the electrical free energy. Persistent efforts have been, and are being, made to solve this problem. One of the earliest to tackle it was Gouy[3]. He did so for a charged colloidal particle which he considered as a rigid structure with static charges distributed on its surface. He calculated the distribution of the ions of electrolytes bathing the surface in terms of the potential due to the surface charge. Gouy's treatment anticipated some of the features of Debye's theory of strong electrolytes. More refined calculations of the electrical energies of colloids have been made by Verwey and Overbeek[4] on the lines of the Debye theory.

Linderstrom-Lang[5] was the first to apply Debye's theory to soluble

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polyelectrolytes. He dealt with the proteins and used a rigid sphere model of the protein molecule. Other models of polyelectrolytes have also been used. Hermans and Overbeek[6] considered a polyelectrolyte chain as a spherical coil into and out of which the solvent molecules and small ions could diffuse. For calculating the electrostatic potential due to the charged spherical coil, they used the Debye approximation of linearising the nonlinear Poisson-Boltzmann equation. This was hardly justified inasmuch as the potential near the heavily charged coil would be quite high as, indeed, was found to be the case when the Poisson-Boltzmann equation for the spherical coil was solved numerically with the help of an electronic computer[7]. The spherical coil model would be untenable when the charge on the coil is high. With an increase in the charge, the sphere would open up. The (electrical) work of charging a 'random' coil has been calculated[8]. At very high charges, the coil would tend to have a cylindrical symmetry. Exact solutions of the Poisson-Boltzmann equation for the cylindrical model have been obtained[9].

How good are the results of all these calculations? The answer to this question would be that, on the whole, they do indicate general trends but quantitative agreement with observation is seldom found. This is what one would expect of any modelistic approach. Actually, the treatments just outlined suffer from several drawbacks. In the first place, the models they use are far too idealised and simple to faithfully represent any real polyelectrolyte molecule. A second defect is the following : they completely ignore the discrete charge-structure of the molecule and assume that the total charge is smeared out as in a metal. This idea of a smeared out charge in a non-metallic structure is not quite novel. In Gouy's theory of the electrical double layer[10], the surface charge was considered as smeared out and a uniform density of the surface charge was used to calculate the distribution of mobile ions near the charged surface. If the centres of charge on the surface are sparsely distributed, the concept of a smeared out charge becomes much too far-fetched and in such a case one should rather think in terms of a distribution of the mobile ions near each charge centre taken separately. Mukherjee was one of the earliest to emphasise this point of view[11].

Objection to the assumption of a smeared out charge in the case of a dissolved polyelectrolyte like protein was first taken by Kirkwood[12]. He considered protein molecules as rigid spheres with discrete charge-structures. The energies of a pair-wise interaction of the charges were calculated and the total electrical energy obtained by summing over all pairs. Kirkwood could predict the titration curve of a protein with the calculated value of the total electrical energy. Since the actual distribution of charges in no protein molecule was exactly known, Kirkwood's theory could not be put to the test of experiment. Kirkwood's idea of a pair-wise interaction of charged sites has since been extended by Rice[13] to the case of flexible polyelectrolytes.

The emphasis laid by Kirkwood on the actual distribution of static charges in a macromolecule underlines the part played by only one aspect of structure. Structural features other than the charge-structure could play a no less important role. They might give rise to specific or chemical effects outside the scope of any theory which recognises only coulombic interactions of charged sites. There is no reason why the electrostatic energy of a polystructure should alone determine its behaviour. Indeed, the electrical energy may itself be a complicated function of the structure in that, the energy of interaction of, say, a pair of charges in a molecule would depend, in a strict sense, on the dielectric

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constant of the part of the molecule which intervenes between the two charges. The value of this dielectric constant would be determined by the actual distribution of electrons and protons in this part of the molecule. Even in the case of a simple dibasic acid with charged sites at its two ends, Kirkwood[14] showed that their mutual electrical influence would depend on the fact that while the seat of a part of the electric field between them is the surrounding medium, its other part is located in the molecule itself. More profound influences of the structure on the electrochemistry of simple molecules are known.

A macromolecule or a macrostructure, in the sense that it admits of possible effects of many more structural variants than a simple molecule, offers a much larger scope to structure influencing electrochemical behaviour. The most direct and perhaps the surest manner in which the role of structure could be studied would be to pick and choose, and, if necessary, produce by actual synthesis, simple and yet typical macrostructures where the structural implications would be obvious and unequivocal, and then examine by actual experiment the part played by particular structural features. This is the kind of approach which has been made by the speaker and his associates for some time past. Though essentially empirical in nature and of immediate value insofar as correlation goes, this approach, we believe, contains the seeds and also the ingredients of a theoretical treatment of polyelectrolytic behaviour in relation to structure. Realising that any such treatment must ultimately make use of a model, and the latter, however refined and informative, would hardly meet all the demands of a complicated case, a theoretical approach has been made so far only in the simplest of cases. A structure which can be described as a quasi lattice develops in concentrated solutions of even quite simple electrolytes. Based on this quasi-lattice structure, as modified by ion-solvent interactions, a one-parameter equation has been obtained[15], with the help of the socalled volume statistics of Glueckauf[16], which predicts activity coefficients over a wide range of concentrations. For the experimental studies, several typical structures, organic and inorganic, were used. The organic structures had the advantage that the C-C or C-N linkages which gave them extension were sufficiently strong to survive rather extreme environmental conditions and this permitted a study being made of the influence of the unimpaired structure on its electrochemical behaviour over a wide range of conditions. The inorganic structures were more susceptible to fragmentation or degradation which, though undesirable at first sight, had its own interest. Linear as well as space structures were studied. Amongst the linear organic structures were synthetic compounds of known molecular weights, like o-ó-dihydroxy diphenyl methane type of novolaks, and linear products of condensation of aldehydes with simple acidic and basic monomers like phenol, cresol and aniline. Crosslinked condensates of aldehydes with monomers like phenol, resorcinol, aniline and metaphenylene diamine were used as typical organic space structures. Their inorganic counterparts consisted of crystalline silicates, e.g., mica and clay minerals. Inorganic polyacids, like polyvnadic acid and polymolybdic acid, were used as representatives of soluble inorganic macromolecular species.

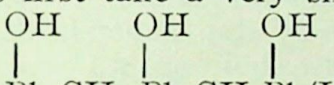
All the structures had one thing in common : they all had acidic or basic groups as structural constituents which gave them the character of polyacids and polybases, and they were studied as such. A classical method which is yet unsurpassed in elegance and in the amount of information on acids and bases which it yields, is the study of their titration curves. The work of Linderstrom-Lang[17] and Kirkwood and

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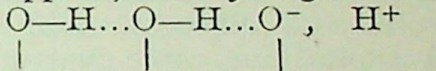
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Tanford[18] on proteins and that of Doty[19], Zimm and Rice[20] and Wada[21] on polypeptides, illustrates the power of the titrimetric method, if one only knows how to use this power. Titration curves of polypeptides, supplemented by optical measurements, have enabled a distinction being made between the three stages of the sequence,—neutralisation of groups on the polypeptide helix, a progressive unfolding of the helix to give a random coil, and neutralisation of groups on the random coil. The titrimetric method was also the back-bone of our experimental approach. It was, of course, reinforced as and when necessary, by other kinds of measurements, e.g., those of optical density and viscosity. I may be permitted to make a reference to some of our observations.

Let us first take a very simple case. We have a trinuclear phenolic



molecule, $Ph\text{-}CH_2\text{-}Ph\text{-}CH_2Ph$(I), in which each of the two methylene bridges is attached to ortho positions relative to a pair of (phenolic) OH groups. In water, the molecule should behave as a weak acid, as indeed, it does. In pyridine, however, one of the three OH groups shows a 'hyper' acid character[22]. Cresol does not show this feature, nor does a poly-phenolic compound in which the methylene bridges are in para position to the OH groups. A steric model of (I) shows that the OH groups can form hydrogen bonds. When this happens, the hydrogen of one of



the end OH groups is readily dissociated, $Ph\text{-}CH_2\text{-}Ph\text{-}CH_2\text{-}Ph$, that is, this OH group shows a 'hyper' acid character. In water, which itself shows a strong tendency to form hydrogen bonds, intramolecular hydrogen bond bridges of the type just mentioned are much less likely to be formed and this, in all probability, is the reason why the hyperacid character is not seen in water. Also, in the case where the methylene bridge between two phenolic nuclei is in a para position to the OH group in each nucleus, the two OH groups are too distantly situated for any hydrogen bond to be formed between them, with the result that the hyper-acid character is absent. One indeed wonders how much could be said in terms of a single structural feature. Nor is this enough. One finds that as the hyperacid OH group is neutralised, the conductance sharply rises and then there is a sharp drop in the conductance as soon as a second OH group, which is the other end OH group, starts getting attacked by the base, sodium methoxide. This peculiar feature is due to ion association and it arises as follows : The negative charge, which is created as the base attacks the hyperacid OH group, is distributed over a rather big molecule and, consequently, the Na^+ ion is comparatively loosely held. The conductance then rises till the neutralisation of the hyperacid OH is complete. When the second OH group at the other end starts getting neutralised, the hydrogen bonds are severed and the two units of negative charge which are created tend to be localised at the two end benzene rings as in phenate ions[23] and they hold the Na^+ ions quite firmly, or, in other words, the Na^+ ions get associated. As a net result, when the second OH group starts getting neutralised, a more conducting species is gradually replaced by a less conducting one, and this accounts for the sharp fall in conductance after the neutralisation of the first hyperacid OH group. The fall in conductance becomes less sharp if either a solvent having a larger dielectric constant, e.g., acetone, is used, or, if the titration is done with an organic base which has a large cation, e.g., tetramethyl ammonium hydroxide. In either case, ion association would be weaker.

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A simple case of much larger linear molecules is that of p-cresol-formaldehyde, a product of condensation of p-cresol with formaldehyde. The product contains chain molecules of different chain lengths. When the shorter chains are removed from the product, the chains which remain have the composition $C_6H_2CH_3CH_2OH$, leaving aside 'end group' effects. From this, the amount of phenolic OH groups in a known weight of the condensate can be calculated. It turns out that 100 gms. have 833 milliequivalents of OH groups. The titration curve of the product shows an inflexion which gives the calculated amount of OH groups. What is more important is the fact that the titration curve also shows other inflexions which are smaller but quite definite and occur earlier during the titration[24]. These small inflexions are found at equal intervals of the added base and they indicate a step-by-step neutralisation of some of the OH groups. All the OH groups in the chain are under the influence of three electron repelling groups, with only one end OH group as an exception. This OH group has a stronger acid character than the others. It is accordingly neutralised at the first small inflexion, that is, this inflexion gives the amount of the strong end OH group. The ratio of the total amount of OH groups to that of the end OH group indicates the average D.P., which, multiplied by the formula weight (120), gives the average molecular weight. Here, then, is an electrochemical method for the determination of the average molecular weight of a system of chain molecules with different chain lengths.

A typical inorganic macromolecule which gives a clear solution in water is decavanadic acid. It is obtained either by the 'dissolution' of vanadium pentoxide or by the action of a strong acid ion-exchanger on a metavanadate. Its solution in water has a light orange yellow colour and a pH of about 3. Its constitution has been inferred from the nature of the titration curves it gives and from the crystal structure of vanadium pentoxide[25]. In this structure, vanadium shows a five-fold coordination with oxygen, giving a distorted trigonal bipyramid. Such bipyramids share edges and corners to produce a space structure which is made up of layers held by weak van der Waal's forces[26]. Water molecules can readily pry through these layers. This is the first step in the dissolution process. In the second step, which is more drastic, fragmentation of the 'infinite' layers takes place by the hydrolytic cleavage of some vanadium-oxygen bonds. A soluble decavanadic acid, $H_8V_{10}O_{29}$, is thus produced, which is made up of two hexagonal rings of linked V−O tetrahedra with a V-O-V bond common to the two rings. Of the eight hydrogens in the V_{10}-molecule, four titrate as a strong acid. They are the first to react with the base. In a second step of this reaction, the base attacks the other four hydrogens and the common V-O-V bond, and the solution now becomes colourless. A large V_{10}-ring is produced which is the metavanadate. It is a macroanion carrying eight units of negative charge. This anion reacts with the alkali in a third step. Here, a progressive degradation of the anion takes place. And at the end of the third step, complete conversion into pyrovanadate occurs. The end point of each of the three steps is marked by a sharp inflexion in the titration curve.

Crosslinked organic ion-exchangers are excellent examples of insoluble organic macrostructures with a pronounced electrochemical character. From a structural standpoint, the case of crosslinked phenol formaldehyde is quite simple. A phenolic nucleus can form a methylene bridge with each of three other nuclei. In this manner, one gets a space structure which is insoluble but open enough for small ions to pass through it. Assuming that all possible methylene bridges have been formed, the

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structure has the composition, $C_6H_2(OH)\ (CH_2)_{1\text{-}5}$; 100 gms. of it should contain 893 milliequivalents of phenolic OH groups. The solid, when finely ground and titrated as a suspension in water, gives a titration curve which shows an inflexion from which one gets almost the calculated amount of OH groups. Even more significant is the fact that the titration curve gives another inflexion at which a much smaller fraction, about 6·0 per cent, of the total OH groups is titrated[27]. These fewer OH groups have a stronger acid character than the others. It is possible that, in the condensation of phenol with formaldehyde, when gelation sets in and there is a rapid growth of the structure, all three reactive positions in some of the phenolic nuclei fail to form methylene bridges with neighbouring phenolic nuclei due to non-accessibility on geometrical grounds, the more so when parts of the structure have already been immobilised. There will thus be phenolic nuclei in the structure having one or two methylene bridges instead of three. The missing methylene bridges constitute what might be called faults in the structure. Insofar as the phenolic OH group of a benzene nucleus which is not fully crosslinked is subject to the influence of a lesser number of electron donating methylene bridges than the OH group of a fully crosslinked nucleus, the former will have a stronger acid character than the latter. On this basis, the fraction which the 'strong' OH groups make of the total number of OH groups in the structure will be a measure of the frequency of occurrence of faults in the structure[28]. Indeed, Houwink[29] had already postulated the existence of faults of this kind to explain the very low tensile strength of phenol formaldehyde compared with its tensile strength calculated assuming complete cross-linkage[30]. Houwink thought that the faults would be distributed in the structure in a random manner. The electrochemical method just outlined seems to go a step further in that it also gives the frequency of occurrence of the faults. As is to be expected, this frequency increases when a more bulky aldehyde e.g., acetaldehyde, or better still, benzaldehyde, is used for the condensation.

As a typical inorganic macrostructure which shows a pronounced electrochemical character, we take the case of mica, a crystalline layer lattice silicate mineral. The crystal structure of mica is very well known[31]. This structure is compact and any ionic reaction in which it takes part must be confined to its surface. A large mica crystal would show poor surface development per gramme and its electrochemical activity would be very weak. Mechanical comminution of the crystal would open up new surfaces on which an ionic reaction could occur. The weakest bonds in the crystal would yield most readily to mechanical stress and the building units of the crystal held by the weakest bonds would be the ones which would be found most abundantly on the surface. The relative strengths of various bonds in mica are known. The weakest of them all is the K-O bond, which is, therefore, the easiest to break. The horizontal component of the stress on the large crystal would only break the K-O bonds, giving plates which would have K^+ ions on their exposed (001) planes and would be less thick than the original (platy) crystal. The vertical component of the stress would also break other bonds giving plates with smaller cross-sectional areas. On the whole, grinding would give smaller and thinner crystals. Their cleavage surfaces will be layers of potassium ions built into underlying hexagonal layers of oxygens. On their lateral surfaces, all the ions of the mica lattice will be represented.

Potassium ions being the most polar constituents of the mica lattice, the cleavage face of mica, on which K^+ ions are distributed, can be the seat of important ionic reactions, e.g., ion exchange. The atomic structure

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of this surface and its charge-structure can be predicted from the known crystal chemistry of mica and the information thus obtained can be used for a quantitative discussion of ionic reactions taking place on the cleavage surface. In the interior of the mica lattice each K^+ ion is co-ordinated by electrostatic bonds to twelve oxygen ions whose centres form two hexagonal rings, one above and the other below the K^+ ion. Cleavage of the crystal brings some of the K^+ ions to the surface. Each such K^+ ion will now be co-ordinated to six oxygen ions if the cleavage has been perfect. The negative charge balancing the exposed K^+ ion resides in the underlying tetrahedral layer of the lattice, being caused by the isomorphous replacement of a Si^{+4} ion in this layer by an Al^{+3} ion. One in every four Si^{+4} ions is thus replaced. There is thus one unit of negative charge for about 45 sq. Å. The negative (isomorphous) charge really acts from the centre of the hexagonal ring of oxygens on which an exposed K^+ ion rests.

When a mica crystal is split along a potassium-bearing plane, the K^+ ions distribute themselves equally between the two parting surfaces. On now directing our attention to the cleavage surface of one of the two plates, we shall find that only a half of its exposed hexagonal rings of oxygens is occupied by K^+ ions while the other half is vacant[32]. When such a surface is brought in contact with water, the K^+ ions on it attract water dipoles and, in so doing, are themselves drawn by the dipoles into the liquid. In other words, a surface dissociation of K^+ ions takes place. The dissociated K^+ ions can and do register their activity on a reversible potassium electrode. The surface dissociation of K^+ ions gives, in effect, an electrical double layer. The structure of this double layer is as unequivocal as might be desired. Its counter ions are the K^+ ions. Its surface charge, which is negative, has a very well understood crystal chemical origin, viz., the replacement of 1 Si^{+4} by 1 Al^{+3}. The location of this replacement and, therefore, of the charge, is known and so also is the surface density of the charge. Indeed, a double layer with a more definite structure could hardly be obtained.

The K^+ ions on the cleavage face of mica can be replaced by H^+ ions, e.g., on treatment with a dilute mineral acid. One thus obtains 'hydrogen mica' with H^+ ions as the counter ions. These H^+ ions can be titrated with a base. If this is done, one gets a titration curve which shows two definite inflexions[33]. At the first inflexion, the H^+ ions of the double layer are neutralised : this inflexion gives an amount of acid which is exactly equivalent to the amount of K^+ ions extracted by the mineral acid to produce hydrogen mica. The second inflexion in the titration curve indicates an amount of acid which is three times that found at the first inflexion. This is just what would be expected if the two hydroxyl groups reckoned for each H^+ ion in hydrogen mica, HAl_2 $(AlSi_3)$ O_{10} $(OH)_2$, reacted with the base at the second inflexion. Actually, the structure of mica is such that for each H^+ ion, two structurally identical OH groups become available for interaction with the base. A better correlation between structure and electrochemical behaviour could hardly be desired. The fact that structural OH groups in mica react with a base has an important bearing on the question of the origin of the capacity of clay minerals to combine with bases. Clay crystals are also layer-lattice silicates and they also have structural hydroxyl groups. It is more than probable that their power to combine with bases is due, at least in part, to such of these structural OH groups as are exposed on the surface[34].

The clays seldom give large single crystals. The clay lattice is definitely less stable than that of mica which can grow to give quite large

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plates. The profile surface of mica crystals is more or less inert and survives rather drastic environmental conditions. The same is not true of the profile surface of clay crystals. Even a dilute mineral acid can mobilise Al^{+3} ions from this surface which then come to occupy exchange sites on the planar surfaces of the clay crystals[35].

Apart from the slight vulnerability of the profile surface of clay crystals, they as well as mica crystals are instances of crystal lattices which resist attack by dilute acids and bases so that the seat of any reaction with the latter is the surface layer. An example where the entire lattice breaks down by the action of the base is the case of barium hydrogen phosphate, $BaHPO_4$. The solid acid phosphate is completely converted into the normal phosphate, another solid, by the action of baryta. The conversion takes place at a constant pH, as is also to be expected from the Phase Rule[36].

I should now conclude this discussion. I hope I have been able to show how profoundly the electrochemistry of macromolecules and ionogenic solids can be influenced by their chemical nature and the geometry as well as stability of their structure,—features, which would be clearly outside the scope of modelistic approaches based on a recognition of the effects of coulombic interactions between ions and charged sites alone.

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SECTION OF GEOLOGY AND GEOGRAPHY

President :—Dr. K. P. Rode, M.Sc., Ph.D. (Zurich), F.A.Sc.

PRESIDENTIAL ADDRESS

ON THE NATURE OF THE ALPINE OROGENY AND CRUSTAL EVOLUTION

I must at the very outset express my sincere thanks to the members of the Indian Science Congress Association for the honour bestowed on me in selecting me to preside over the Geology and Geography Section this year. I feel I have hardly any claims to this high honour and take this merely as an opportunity for rendering accounts of my long standing debts to the Science of Geology before I leave my active post.

It is now more than two decades when as a research scholar at Zurich at the foot of the mighty Alps an intense craving overtook me to understand the inner secrets of the Earth as exemplified, on the one hand, in the beautiful little crystals so abundantly developed in the Alpine crevices and, on the other, in the mighty mountain ranges like the Alps. The masterly treatment of the principles of crystal-chemistry and petrochemistry by the revered Late Prof. Paul Niggli helped me to peep into the kaleidoscopic nature of the crystals, minerals and rocks, while the equally masterly treatment of the Nappe Structures in the Alps and of the Crustal movements by Prof. Rudolf Staub led me into the fascinating but intricate field of orogenic and continental evolution. Whatever the outcome, these studies at Zurich have left in me a deep and abiding interest in these widely divergent fields of the Geological Science.

The most fundamental problem in the field of Geological Sciences is the nature of Crustal Evolution. This subject is of utmost interest not only to the Geologists and Geographers but also to the students of other allied Sciences—physical as well as biological. The nature of our solution to this problem would guide the whole course of development in these Sciences. I, therefore, propose to place before you certain interesting aspects of World Geology with a view to focus your attention on the problems involved and to see if some satisfactory solutions could be worked out for them without introducing any unwarranted postulates. Hence, I have chosen as the theme of my today's Address *'The Nature of the Alpine Orogeny and Crustal Evolution'*. I do admit that it is too ambitious and almost too presumptuous on my part with limited resources and time to attempt such world-wide problems.

The Continental Crust is characterised by the development of stratified rock-formations in belts exhibiting diverse trends and grades of folding. These have been studied in different countries often in detail but most of these studies have attempted solutions of the involved

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problems more or less on the basis of local geology. These solutions have at times been utilised for making generalisations although not all of them are applicable over larger areas. It was, however, the genius of Prof. Edward Suess who, on the basis of the data then available from different parts of the world, brought out a brilliant synthesis in which we find the first glimpses of the evolution of the accessible Crust as a whole. (Suess, 1909). The irregularly spread shreds of geological formations were woven by him into orderly assemblages whose role in the Crustal Evolution could be easily appreciated. He thus visualised the stable continental shields as distinct from the labile belts and the role of the latter in the expansion of the former. He further recognised certain major periods of orogenic upheavals separated by long intervals of quiet geosynclinal sedimentation and on this basis worked out the time stages in the Crustal Evolution.

This synthesis of crustal evolution was based on the basic postulate of the permanency of continents and oceans which governed all geological thought of that period. This could some how explain the broad facts of geology known till then.. However, with more detailed studies particularly in the structure of the Alps the faith in the permanency of the continents began to be shaken as it could hardly explain the extensive horizontal movements of the vast sedimentary Nappe packets clearly demonstrated in the Alps. This concept of permanency could not also stand the strain in explaining the faunal and floral similarities observed in distant continents in the geological past. A. Wegener stepped in at this stage and advanced his radical concept of Continental Drift which was enthusiastically hailed by biologists and palaeontologists (Wegener, 1924). He, however, failed to satisfy the geophysicists or even the geologists since neither the geological fittings on the opposite coastlines were satisfactorily realised nor could appropriate earth forces be demonstrated which could move continents, 60-90 Km. thick, laterally over any considerable distances particularly when they were surrounded by a jacket of solid sima 50-80 Km. thick under the oceans.

I The Alpine Orogeny

For any understanding of the nature of crustal evolution the evidences available in the orogenic belts are very helpful and at times very decisive. The geosynclinal sediments involved in these belts not only give evidences about the faunal relations between different geosynclines but they also give indications about the relative position of the various continents during different geological periods. The earlier orogenies including the Caledonian and the Variscan are only fitfully developed or preserved (Umbgrove, 1942). It is only the Alpine Orogeny which is magnificently developed encompassing, as it does, almost all the continents of the world. It is, therefore, most appropriate that in our study of the crustal evolution we consider the structure and evolution of this Orogeny in some detail.

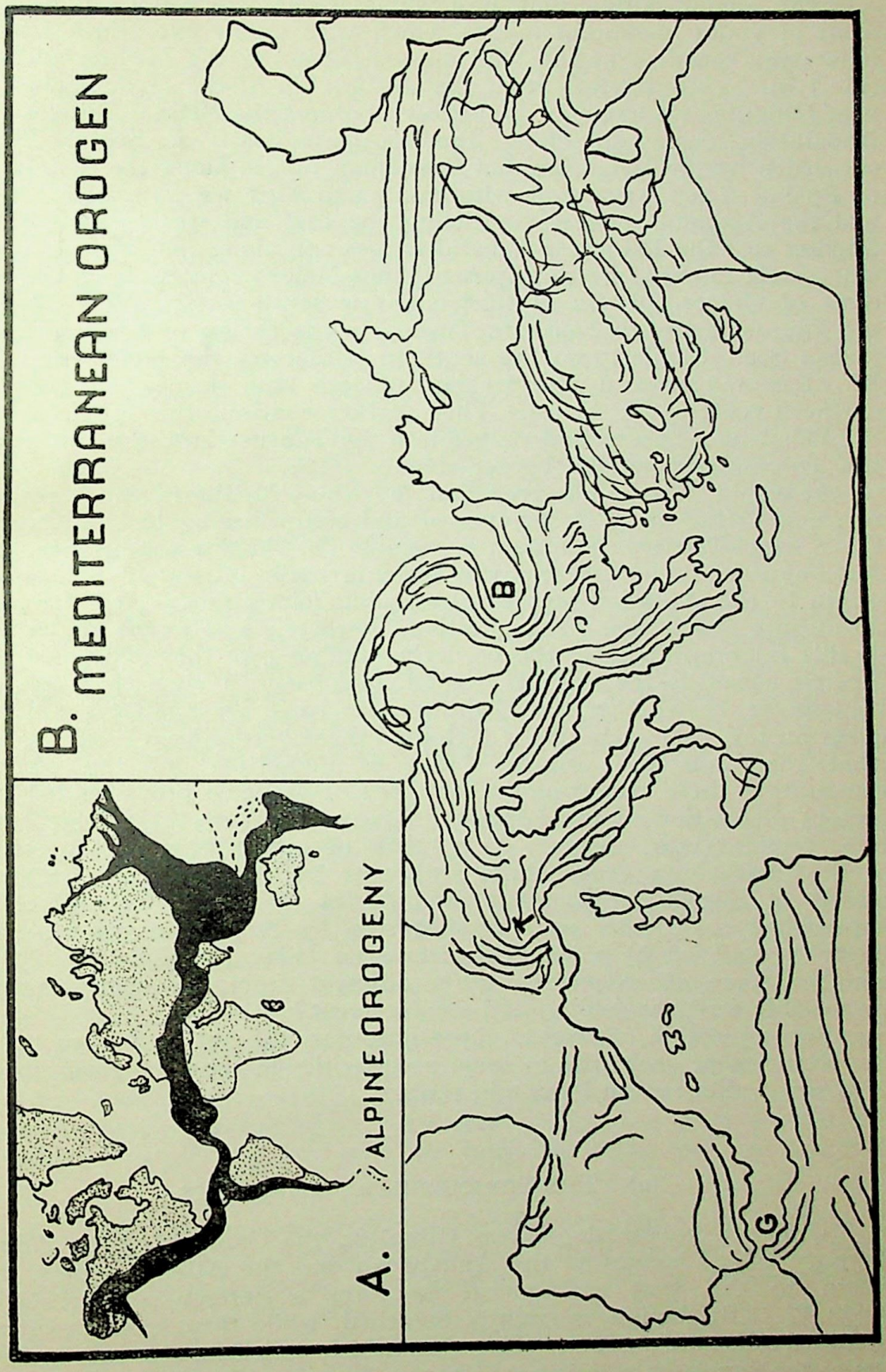
The Alpine Orogeny not only comprises the Mediterranean mountain system which can be followed uninterruptedly right from China on the east to Spain on the west and can be recognised even in the Tropical American region across the Atlantic Ocean, but it also comprises the Circumpacific system of ranges represented by the Andes, the Rockies and the East Asiatic Arcs (Staub, 1928). (Pl. 1,A).

Let us begin with the study of the the mountain ranges developed in the Mediterranean region.

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PL. I



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A. The Mediterranean Orogen

The Mediterranean Belt as a whole is characterised by the development of young mountain ranges which with a few exceptions faithfully follow the coastline of the land masses bordering the Mediterranean Sea (Pl. 1,B). Thus starting from the western tip of the Mediterranean Sea near Gibralter we have on its northern borders the Betic Cordillera or the Andalusian chain all along the southern coast of Spain. This is succeeded by the Valencian and Catalonian ranges along the eastern coast of Spain. Then associated with the main Alps we have the Legurian and the Apennine ranges paralleling the east and west coasts of Italy. Further east the Dalmatian-Dinarid ranges run along the Adriatic coast of Yugoslavia followed by the Epirus-Pindos-Malevo ranges along the Ionian coast of Greece. These in turn continue south-east through Crete into the Taurus ranges of Southern Turkey in the region of Eastern Mediterranean Sea. Similarly on the southern borders of the Mediterranean the Rif-Atlas ranges and the Lybian uplands run nearly all along the northern coast of N. Africa. They further continue through Cyprus and the Palestinian-Lebanonian ranges into the Taurus-Kurdistan ranges along the Turco-Mesopotamian border (Staub, 1928).

It would thus be observed that the whole Mediterranean border from one end to the other is surrounded and controlled by tectonic ranges of the young Tertiary mountain system. The Mediterranean Sea, therefore, appears to be essentially a tectonic basin intimately related in its origin to the evolution of the surrounding folded ranges and there exists no dispute about this. The question, however, is as to the actual nature of this relationship. Do the bordering ranges owe their existence to the Mediterranean as the original geosynclinal basin, a view most commonly held so far, or whether the Mediterranean basin itself is later and consequent on the disposition of the tectonic ranges bordering it? If the latter, what then was the original basin of deposition for the sediments constituting these ranges and what types of orogenic processes led to the present disposition of these mountain ranges? Were these folded mountains brought into existence as a result of compression or squeezing in of the intervening geosynclinal sediments by the bordering continental masses of Europe (or Laurasia) and Africa (or Gondwanaland) as they approached each other as was suggested by Suess and others, and is devoutly believed by most geologists even today (Brinkmann, 1960), or whether some other process quite different from the above could be responsible for their folding and emplacement?

For a possible answer to these questions the author wishes to draw the attention of geologists to some peculiarities in the geological structure of these Mediterranean mountain ranges.

(a) The Semicircular Alpine Arcs

(i) *The Gibralter Arc*—Near Gibralter, the Gateway of the Atlantic, Tertiary folded ranges of the Andalusian and the Atlas gradually curve round to the west and merge to form a perfect semicircular arc (G in Pl. 1,B) though apparently breached, while they appear to diverge eastward (Krenkel, 1957). This Arc which may also be called as Rif-Betic Arc serves as a link between the European Continent on the north and the African Continent on the south. It is constituted largely of folded Mesozoic and Tertiary strata though Palaeozoic and Pre-Cambrian

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basement formations do occur occasionally as isolated horsts or inliers. All the fossiliferous formations exhibit typically Alpine faunal affinities (Brouwer, 1927).

(ii) *The Western Alps Arc*—Moving north-east for about 1300 Km. from Gibralter along the coastal regions of Southern Europe we again come across another remarkably similar semicircular Arc of the well known Western Alps near Turin (T in Pl. 1,B) on the Franco-Italian border. Here, again, the Arc is composed of highly fossiliferous, folded Mesozoic and Tertiary formations resting on Palaeozoic and older basement formations which also exhibit identical trends. This arc in turn serves to connect two folded linear ranges, the Swiss-Austrian Alps at the northern end and the Apennine at the southern. The Swiss Alps are among the best studied mountain belts of the world and their intensely complicated structure has led to the development of the Nappe theory which has been widely applied to elucidate structures of other folded belts of the world. (Heim, 1922 ; Argand, 1916 ; Staub, 1924 ; Heritch, 1927).

(iii) *The Balkan Arc*—Further to the east about 1300 Km., down the Danube basin, we come across east of Belgrade yet another semicircular Arc now of the Transylvanian-Balkan Alps (B in Pl. 1,B). Here again we find highly folded Mesozoic and Tertiary formations with faunal assemblages of typically alpine affinities resting on Palaeozoic and older basement.

What is the significance of these three widely separated semicircular arcs as developed within the linear fold system of the Alpine Belt? Do they represent independent mouldings of the Alpine folds against the unyielding foreland horsts which they had to negotiate individually during their northward advance, as is generally believed by most Alpine Geologists? To realise their true significance let us study them a little more closely.

On comparing these three Arcs among themselves we are surprised at the extent of their similarities which are clearly brought out if we place them side by side. (Pl. 2, A, C). All of them are nearly perfectly semicircular in shape, almost equal in size, are composed of nearly identical series of rock formations faunally very closely related, are all invaded by igneous rock masses of almost identical ages and exhibiting identical pattern of areal development (Burri, 1949), and are similarly serving as linkages of important mountain chains at their either ends. We can go still deeper in their relationships by bringing the three arcs in superposition. We find that the arcs not only show structural similarities but even identity with complimentary relations in the development of rock formations including the intrusives within the Arcs so that the rock formations of one arc continue into the other in corresponding positions.

These far reaching similarities or identities cannot all be fortuitious or accidental and do call for an explanation. They can not be explained if the Arcs were independent mouldings. They can be explained only on one basis that these Arcs must have been originally the components of a single compact superposed folded structure and which later got split into independent units by some crustal process not yet fully comprehended. Before dilating on this process just here let us study the nature of the linear Alpine chains occurring associated with these semicircular Arcs.

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(b) The Linear Alpine Chains

At their southern end the Gibralter Arc continues into the Atlas range, Western Alps Arc into the Legurian-Apennine range and the Balkan Arc into the Rhodope range in the Greeco-Bulgarian region. It may, however, be added that in between the Western Alps and the Balkan Arcs we find an incomplete arc—the Carnic-Venezian Arc, east of the Adige, which continues into the Dinarid range of Yugoslavia. Now let us examine the relationships first between the Dinarid and the Apennine ranges which run parallel to each other on the opposite sides of the Adriatic Sea.

(i) *The Dinarid-Apennine Relationships*—The trends of the various rock formations as developed in these two ranges are remarkably parallel. The Dinarid range east of the Adriatic Sea, however, is largely constituted of the Palaeozoic and Mesozoic formations with only traces of the Lower and Upper Tertiary formations. The Apennine range, west of the Adriatic, on the other hand, is largely built of the Tertiaries with only small stretches of the Creataceous and Jurassic formations (Teichmuller, 1935). The Tertiary-Quaternary development in the Po basin along the northern borders of the Apennines has an almost exact duplicate in the Tertiary-Quaternary deposits of the Drave basin along the northern borders of the Dinarid range, with only one difference that whereas Upper Tertiaries are dominant in the Drave basin the Quaternaries dominate in the Po basin.

It would thus be seen that though the structures in the two ranges are identical the older formations abound in the Dinarid range while the younger formations in the Apennine range. The real nature of their relationships, however, comes out the moment we superpose the Apennine Sheet over the Dinarid Sheet (Pl. 2). It would be observed that the Tyrrhanean or western coast of the Apennine is an exact replica of Adriatic coast of the Dinarid range including the island system. In addition most of the structural lines become coincident, while the rock formations exhibit complimentary development such that the rock formations found suddenly disappearing in one sheet are found to reappear in the other sheet exactly at the corresponding positions.

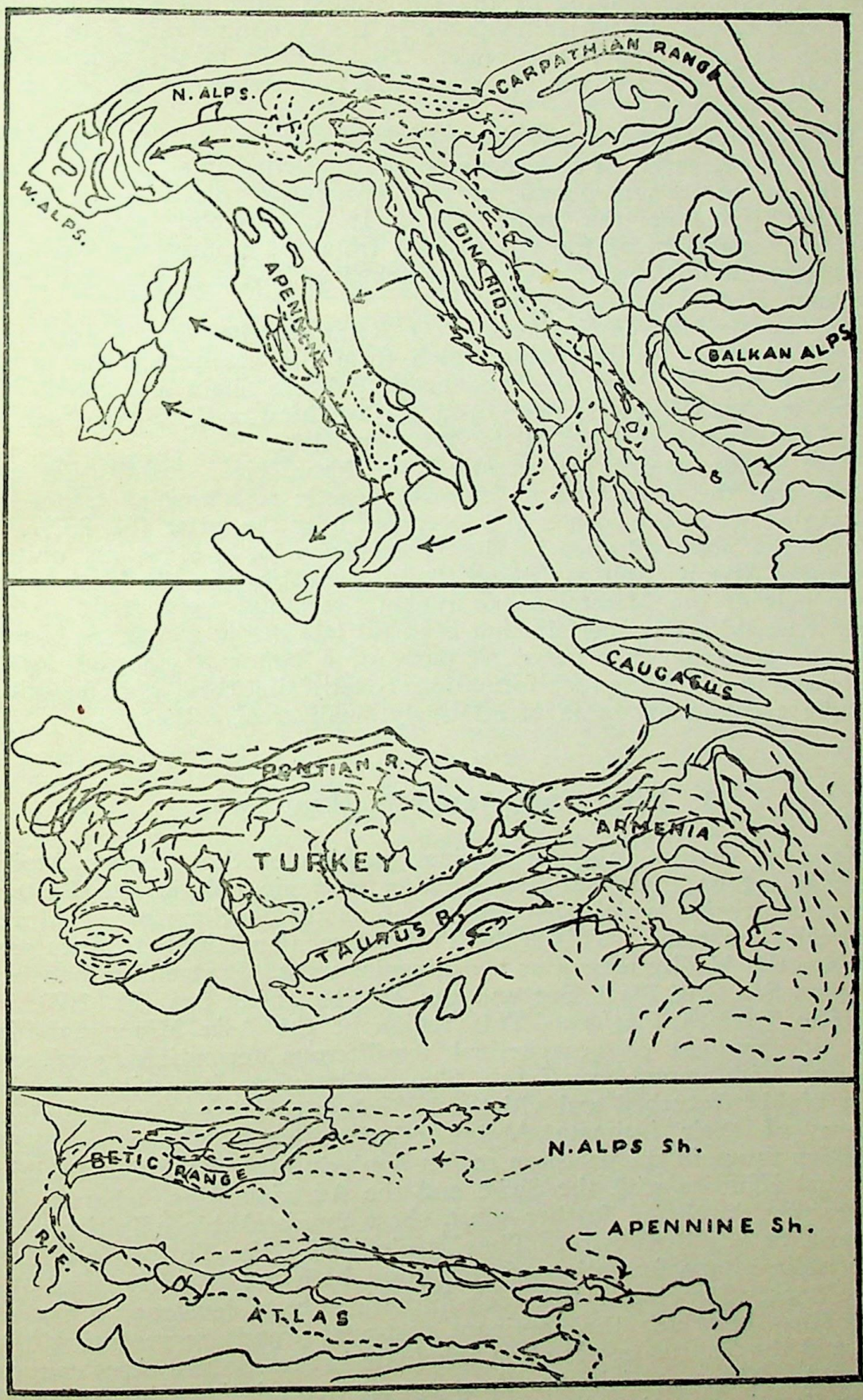
These facts leave absolutely no doubt that these two sheets were actually parts of one common superposed structure for the greater part of the geological history and that they were separated through slicing and sheeting some time during the late or post-Tertiary period with the development of the Adriatic Rift. It is thus possible that the overthrust or nappe structures recognised in ranges and in which vast rock sheets appear to have moved considerable distances almost horizontally over younger rock formations (Teichmuller, 1935), may owe their development to the relative westward movements of the Apennine sheet over the Dinarid basement as is suggested above. Again the same westward movement of the Apennine sheet appears to have left behind an extensively rubbed or eraded Karst plain studded with islands along the Dalmatian coast.

(ii) *The Apennine-Atlas Relationships*—Almost similar relationships appear to exist between the Apennine and the Atlas ranges although they are not so obvious owing to their present geographical location. These can be easily appreciated if we place the geological maps of the two regions side by side as in Pl. 2. It would be observed that the Adriatic coast of the Apennines for a large part coincides with the Mediterranean coast of the Atlas. The Tyrrhenian coast appears to correspond with the lake

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PL. 2



MEDITERRANEAN OROGENIC ARCS

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belt north of the Anti Atlas range. The structural trends are remarkably similar. Geologically similar rock formations, faunistically very closely related, go into the making of the two ranges with the difference that whereas the Lower Tertiaries dominate in the Apennine range the Upper Tertiaries do so in the Atlas range. The identity in the relationships comes out clearly when we superpose the two structures as shown by dotted lines in Pl. 2,C.

The position of the intervening islands of Corsica, Sardinia and Sicily in relation to the sheets of the Apennine and the Atlas on either side is also easily made out when placed in the superposed position, as shown by dotted lines in the same plate. It is thereby realised that during the separation of the Atlas sheet from the underlying Apennine sheet, fragments of these sheets got detatched and were left behind in the intervening Mediterranean region.

(iii) *The Andalusian-Northern Alps Relationships*—If we now turn to the other set of linear chains which form the northern limbs of the semicircular Arcs we have the Andalusian-Balearic chain associated with the Gibralter Arc (Brouwer, 1927), and the Northern or the Swiss-Austrian Alps associated with the Arc of the Western Alps.

These linear chains are identical in shape, size, constitution and structure, and the same type of intimate genetic relationships comes out unmistakably when the former is superposed over the latter (Pl. 2,C).

From the above studies in the relationships of the various units—Semicircular Arcs as well as Linear Chains—constituting the long Alpine orogenic belt of the Mediterranean region extending from Spain to the Balkans it would appear certain that even till late in the geological history they were occurring superposed as parts of a common compact folded structure and in which the rock formations constituting them were deposited in a single geosynclinal basin of relatively small areal extent.

B. The Turko-Armenian Highlands

Before we enquire into the original location of the primary Alpine geosyncline, let us study another complex orogenic belt in the Eastern Mediterranean region which also exhibits abundant development of Alpine type of rock-formations. This is the Turko-Armenian Highland mass projecting into the Mediterranean as a peninsular mass. It stretches between the Caspian Sea, the Black Sea and the Mediterranean Sea (Pl. 2,B).

(i) *The Turkish Platform*—This region of the Asia Minor exhibits a fitful development of geosynclinal fossiliferous formations profusely interspersed with young eruptives. The sedimentary formations inspite of being highly disturbed and vitiated by volcanic action show abundant indications of their intimate Alpine relationships (Philippson, 1918). The Pontian range in the northern region bordering the Black Sea exhibits clear faunal affinities with the Swiss and the Austrian Alps, whereas the Taurus ranges developed further south show unmistakable affinities with the Dinarid or Southern Alps. Thus, geologically, the Turkish platform includes sedimentary formations representing both the Northern and the Southern Alps. Structurally the rock formations have developed a mosaic of trend lines in which the dominant east-west trends representing the Pontian and the Taurus trends often terminate in semicircular Arcs convex to the west. These semicircular Arcs appear several times in a general east-west direction starting from the Kara basin in the east through Kisil and Sakaria basins right upto the Aegean Sea-board on the west.

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Thus structurally as well as faunistically the geological formations found developed here present the closest parallels to the Alpine ranges of Southern Europe. It, therefore, appears very likely that the Turkish peninsular mass actually served as a regular platform over which the various Alpine sheets in their superposed position had their full evolution. The Aegian islands, on the other hand, represent the route over which the Alpine Sheets on being detached from their Turkish basement migrated to their present sites to encompass the whole Mediterranean region.

(ii) *The Armenian Highlands*—Adjoining the Turkish platform on its east and north-east are the Armenian Highlands which are a veritable knot and are characterised by an abnormal development of volcanic and flysch facies associated with geosynclinal sediments showing pronounced lithological and faunal affinities with the Carpathian formations (Oswald, 1911). Remarkably the arcuate circular trends developed in this region also reproduce exactly the structures of the Carpathian ranges. If the latter structures are superposed over the Armenian ones the identity between the two becomes complete. The Armenian mass then appears as a central core while the Carpathian Arcs appear as peripheral to them.

We thus see in this Turco-Armenian peninsular mass a platform which must have served as a basement stage not only for Alpine but even for the Carpathian Arcs as well, for major part of their evolution before they migrated to their present location.

(iii) *The Caucasus Range*—Besides these two units constituting the Turco-Armenian Highlands there is a third structural unit associated with them. This is the Caucasus range which appears as an independent chain with trends quite tangential to those of the Armenian arcs. This range is formed mainly of the Jurassic formations with a core of the Palaeozoics, and with fringes of the Cretaceous and Tertiary deposits. The strata on the northern slopes of this range exhibit many affinities with those of the Central European and Thian Shan faunal provinces, while those on the southern show abundant relationships with the Alps and the Carpathians (V. Stahl, 1923). This chain appears to terminate abruptly against the Caspian Sea on the east and against the Black Sea on the west, and as such appears only as a fragment or a partial manifestation of a long chain not fully exposed here. The relations of this chain with the Armenian and other neighbouring ranges cannot be made out and we see here only a close approach or *scharung* of two divergent trends.

C. The Hindukush-Pamir Highlands Complex

The *scharung* or fusion of ranges with divergent trends as seen in the Armenian region is, however, observed on a much grander scale in the region of the Pamirs in the Central Asian Highlands (Lauchs, 1916; Norin, 1941). Here the Himalayan-Karakoram ranges trending roughly in a SE-NW direction are found to meet obliquely with the Hindukush ranges trending SW-NE and with the Thian Shan ranges in the north trending roughly E-W with the Alai and Kirgiz arms suddenly directed NW, oblique to the main trend. The region of the Pamirs is tectonically probably the most complex structural unit, a veritable Knot, on the earth's surface. Physically also these Pamirs, next to Tibet, form almost the highest plateau on the earth's surface averaging about 5000 metres in altitude, flanked on either side, surprisingly, by sudden depressions—the Tarim basin on the east and Turkmen-Turanian plains on the west—both dropping down precipitously almost to the sea level.

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If we compare the two plateaux, the Armenian in West Asia with the Pamir in Central Asia, we are surprised with the numerous similarities—geological, tectonic, and even geomorphological—observed in them. Thus the typical Tertiary Alpine folds of the Himalayas running SE-NW are comparable to the south-west Persian (Luristan-Bakhtiary) ranges exhibiting similar Alpine folds (Gregory, 1929). The Hindukush ranges correspond to the Turkish highlands running WSW-ENE. The Thian Shan range with its Alai and Kirgiz arms corresponds to the Caucasus range in having similar linear trends, while the Pamir Plateau exhibits the same circular trends as obtain in the Armenian highlands. Even the depressions—the Tarim and the Turkmen—on either side of the Pamirs have their corresponding depressions in the Caspian and the Black Seas on either side of the Armenian Plateau.

Similarities more far reaching than merely morphological can be realised if we superpose the Turko-Armenian Sheet over the Hindukush-Pamir Sheet. It is notable that the structural patterns are identical both in form and size. They are, further, constituted of geological formations faunally closely related and exhibiting complimentary relationships in their development i.e. the older formations dominating in the Pamir highlands whereas the younger formations dominate in the Turco-Armenian Sheet. Such far reaching correspondences in the structure and the build of the two regions now separated by nearly 2500 Km. can be explained only on the basis of their original superposition and later separation through movements of the Sheets. Thus we come to the possibility that the Turco-Armenian highland mass was actually resting as a super-structure over the Hindukush-Pamir basement even during the Tertiary Era and that the igneous activity connected with the Laddakh-Burzil volcanics may have played an effective role in bringing about the above sheet movements.

On these considerations it appears quite plausible that all the Alpine, Dinarid and Carpathian Arc systems, together with the Turco-Armenian Highlands as their sub-stage, were in the early stages of their evolution actually resting as a compact superposed sheet-complex over the Hindukush-Pamir basement. Later they migrated gradually to their present location through successive *en échelon* movements along the routes abundantly marked by the remnants of the Alpine Sheets left behind during these lateral movements. These routes now constitute the latitudinal Alpine Belt stretching from the Pamir plateau to the Atlantic coast of Spain.

The Pamir Syntaxis

The relations of the Hindukush-Pamir ranges with those of the Spiti and Kumaon Himalayas and the nature of the Indus or the Pamir Syntaxis have already been discussed elsewhere (Rode, 1954). It was shown therein that the Hindukush belt had its original home in the Kashmir-Kumaon Himalayas, and that the Hindukush Sheet along with its superstructure when detatched from its Himalayan basement moved radially with the Pamir as pivot, in a clockwise manner through a system of rifts represented by the Indus and its tributaries.

Thus it seems most probable that the whole Alpine chain west of the Pamir had its earliest home in the Karakoram-Himalayan zone which then appears as the Primary Geosyncline in which all the Mesozoic and Lower Tertiary sediments constituting the Mediterranean Alpine belt

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were actually deposited. It is from this primary Tibeto-Himalayan basement that the Alpine Sheets got detatched and displaced through igneous processes remarkably represented by the phenomena of Exotic blocks of Malla Johar and Tibet.

D. The Central American Orogen

The nature and evolution of the Central American Orogen has been discussed in a communication read at the Mexican Session of the International Geological Congress, 1956 (Rode, 1956). It was shown there that all the Caribbean, the Antillean and the Mexican gulf systems of folded arcs were originally a single series of superposed sheets constituting an integral part of the Alpine Atlas system east of the Atlantic and that they suffered radial movements in an anticlock-wise manner while still resting on the Euro-African basement. This gave rise to a large number of independent Arcs of the Antillean System before they migrated westward along with the bordering continents of North and South Americas ultimately leading to the development of the vast Atlantic Ocean. This then appears to be the Nature and Mode of Evolution of the Alpine Orogeny of the whole east-west belt from the Pamirs to Mexico.

II Evolution of Continental Crust

Having studied the evolution of the labile folded belts of the intracontinental system let us now see what light it throws on the mode of evolution and emplacement of the cratonic continental masses of this vast region, particularly the continents of the New World.

From the study of the Americas it is clear that the coastal Cordilleran belt marks the western boundary of the North American continent whereas the Andean range limits the continent of South America to the west. It is, therefore, obvious that the evolution and emplacement of these continents of the New world are intimately bound up with the evolution of the bordering orogenic belts—the Rockies and the Andes.

A. Relations between the Circumpacific and Mediterranean Orogens

Let us now study the relationships of these longitudinal Rockyan and Andean orogenic ranges with the latitudinal Alpine belt. Taking first the Andes it is seen that the closely bundled Arcs of the Equador and Columbian Andes gradually fan out into the radiating Arcs of Cordillera de Meride in Venezuela and Trinidad (Gerth, 1935 ; Sapper, 1937). The same radiating system reappears in the Antillean Arcs of Caribbean and the Mexican Gulf regions (Schuchert, 1935 ; Rode, 1956). Similarly in North America the Rockies and the Coastal ranges pass imperceptibly into the Californian and Mexican ranges of the Central American orogenic belt which, as seen above, genetically belong to the Mediterranean mountain system. Thus the longitudinal belts, both of the North American Rockies and the South American Andes, are intimately connected with the Alpine-Himalayan system and as such their evolution and emplacements appear to have been brought about by the same series of crustal movements as have given rise to the east-west Alpine belt. Since the Alpine orogenic belt has suffered *en échelon* extension through periodic westward movements it is obvious that the emplacement of the North and South American continents was also effected by the same series of the earth movements.

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In another paper on the *Evolution of the Southern Continents* read at the Mexican Session of the International Geological Congress the author has shown how the South American continent constituted a superstructure over the African platform and how the whole of the Afro-American sheet-complex suffered successive westward movements from its original Indo-Himalayan basement (Rode, 1958 ; 1959).

It can similarly be shown that the North American continent constituted an integral part of the Eurasian sheet-complex to form Laurasia which also suffered lateral movements from its original home-land in Central Asia by the same series of earth movements as brought about the distension or *en échelon* extension of the Alpine chain in the Central Asian, Mediterranean and the Central American sectors.

B. Mechanism of Sheet Movements and Continental Expansion

This new mode of approach based on the application of the Theory of Sheet Movements and Continental Expansion as developed by the author over a decade back helps us to solve most of these important problems in geology without recourse to any unwarranted postulates (Rode, 1952 ; 1953). The various authorities in the field of world tectonics had already recognised many close similarities—faunal, floral, lithological etc.—in geolgical formations of even distant lands (Haug, 1930) etc. However, being wedded to static concepts in continental or geosynclinal evolution they have tried to explain the observed similarities by introducing numerous postulates such as identity of environment ; identical organic evolution at independent centres ; possibilities of rapid migration over distant regions even of plants and benthic marine faunas inspite of their restricted means of migration ; world-wide uniformity of climates without climatic zoing over the whole globe ; polar wandering at amazingly rapid rates, etc. (Neaverson, 1955). Many of these postulates are purely hypothetical and are incapable of being realised. Even granting these, they may explain only some of the observed similarities but none of them is capable of accounting for repetition of identical regional structures over vast distances ranging to thousands of kilometers.

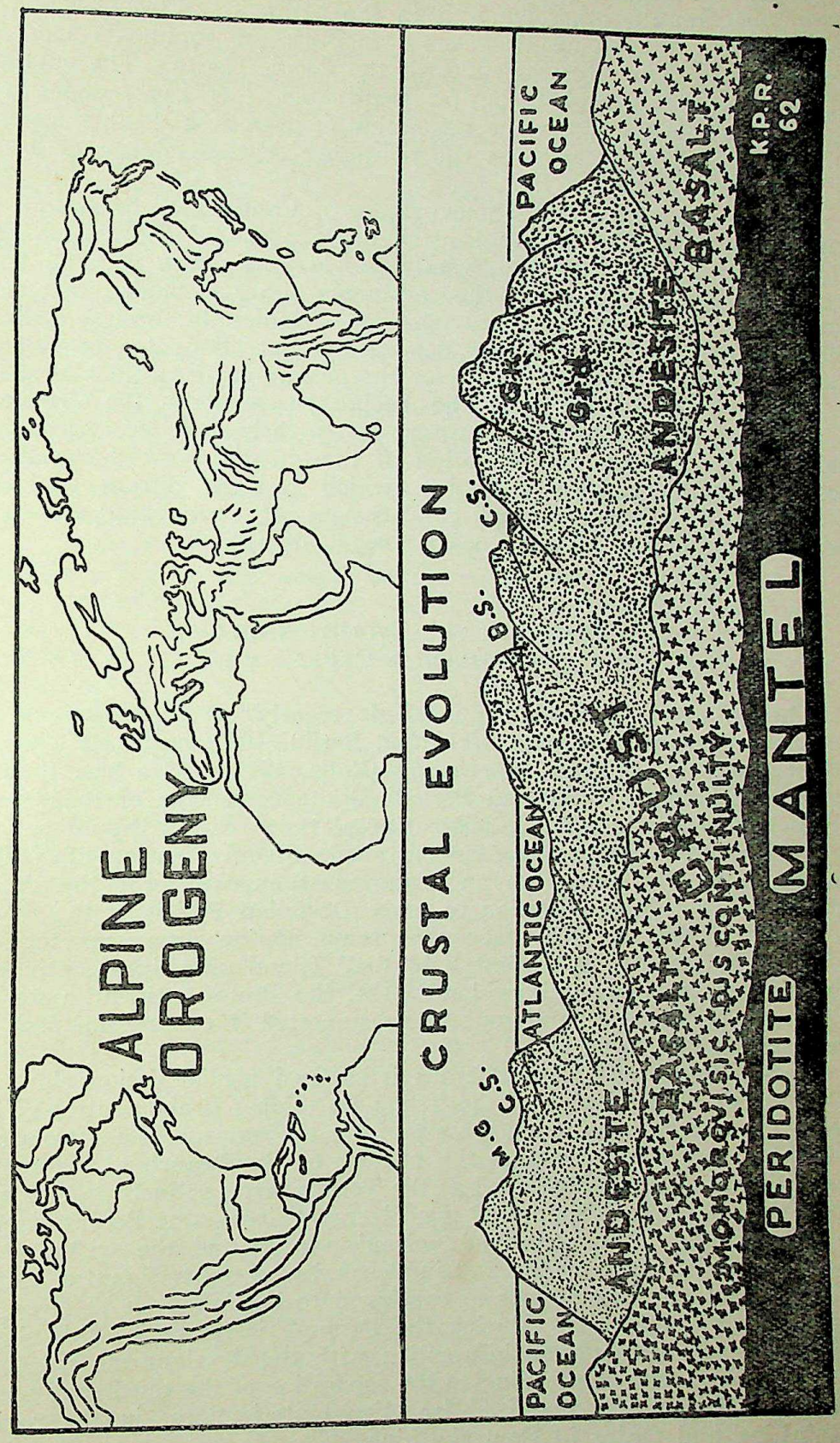
These geostructural identities demand some mechanism of lateral movement of vast crustal sheets over considerable distances almost in undisturbed condition. This mechanism can only be of liquid transport repeatedly available from place to place. Such a liquid medium capable of transporting rock sheets of vast dimensions can only be of fluid lavas, especially basic lavas which being of higher specific gravity than most of the crustal rocks, are capable of lifting and floating vast rock masses like heavily laden ships floating over river waters. Such basic lavas of vast magnitude are normal manifestations of circumpacific vulcanism where a whole belt, nearly completely encircling the continental hemisphere, is almost continuously in a state of subcrustal fusion permitting repeated eruptions along extensive fissures. When these enormous lava sheets penetrate stratified formations of the overlying geosynclinal belts along continental borders, they would induce extensive granitisation and also lift vast rock sheets and make them float and slide gravitatively towards lower levels of the adjoining Pacific floor.

The repeated expansion and migration of the geosynclinal belts bordering the continents towards the Pacific depths is thus the principal

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PL. 3



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mechanism of continental expansion. The Alpine type of Mediterranean geosyncline, on the other hand, is in the nature of intracontinental rift system along which vulcanism serves to push the continents apart and thus facilitate their migration towards the Pacific Ocean. The vulcanism in the Mediterranean belt is, on the whole, less basic—andesitic to rhyolitic. It thus helps in the generation of granitic and other materials which get directly accessed to the bordering continental masses leading to their expansion.

We thus see that the whole process of Continental Expansion and Continental Migration takes place at the expense of the Pacific floor. The Pacific basement rocks not only provide the entire material which goes into the composition of the continents either through direct accession as eruptive or as granitised material or indirectly through sedimentation in geosynclinal or other depressions but they also provide the liquid medium, as also the space, for the migration of continental sheets.

We may then look upon the Pacific basement as the Primordial Crust all covered by the oceanic waters in the early or pregeological times and it was only the transformation of the simatic floor of the Pacific Ocean through repeated vulcanism which resulted during geological periods in the formation and emplacement of continental masses in isostatic equilibrium with the oceanic segments (Pl. 3).

C. Stages in the Evolution of the Continental Crust

The author in an article published recently in *Abhandlungen der deutscher Akademie der Wissenschaften,* Berlin, 1960, has dealt with the earliest stages in continental evolution (Rode, 1960a). He has, therein, shown that before the Silurian Period all the continents of today were only in the nature of a single submarine platform within the all pervading Pacific Ocean and serving as the abode of only marine life. This platform gradually grew into an island mass exposed over the Pacific waters first in the late Silurian or early Devonian Period in the region of Tibet. It was at this stage that some marine organisms took to terrestrial habitat. This earliest 'Old Red' Island grew into continental dimensions as a single unitary land mass, the Proto-continent, upto the Lower or Middle Carboniferous and supported the uniform flora so characteristic of this period.

During the Upper Carboniferous it suffered medial fission along an east-west rift in the region of the Tsang Po (Upper Brahmaputra) giving rise to a northern continental mass to form the nucleus of Laurasia and a southern continental mass as the nucleus of Gondwanaland, while the intervening medial rift developed as the Tethys (geosynclinal) Sea. These two continental masses supported two divergent floras—the Pecopteris and the Glossopteris. The continued vulcanism permitted the widening of the Tethyan rift, more on the east in the region of upper Yangtse Kiang, while the two continental masses continued to be linked on the west in the region of the Pamirs. During the Permo-Triassic Period this single medial Tethyan rift suffered bifurcation with the development of a new rift along the Huang Ho leading to the separation of the third continental mass of Catheysia, characterised by Gigantopteris flora, in the region of TsinLing and Ordos in Central China.

During the Mesozoic Era vulcanism caused the geosynclines to expand by pushing apart the adjoining continental masses, whereas the

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magmatic flooding during the Upper Cretaceous-Tertiary periods brought about extensive splittering, sheeting and migration of continental and geosynclinal belts to long distances partly in a radial and partly in *en échelon* manner. By the end of the Tertiary Era the continental crust comprising the Laurasian, the Gondwana and the Catheysian Land masses together with their associated geosynclinal belts occupied the area of the Old World from Spain to the Philippines. Further separation and successive westward migration of the North and South American continental sheets constituting the New World from the Euro-African mass during the Quaternary period led to the widening of the Atlantic rift which quickly developed into an enormous ocean. In the same way the migration of the Antarctic and Australian continental sheets to the south and south-east led to the broadening of the Indian Ocean.

Such appears to be the nature of evolution of the Continental and Oceanic Crust of the Earth as we find it today. This Theory also explains the remarkable bilateral symmetry about an E-W Axis which is discernible in the morpho-structural patterns of the Earth as a whole (Rode, 1960).

It would thus be observed that all the major problems of Crustal Evolution in regard to the processes, forces and mechanism, trends and stages both in time and space, can all be worked out quite precisely on the basis of the unitary and yet all comprehensive *Theory of Sheet Movements and Continental Expansion* as developed by the author during the last decade. This Theory would also help in understanding the evolution of Palaeobiolgical Provinces so essential in ascertaining the Evolution of Life on the Earth.

Before I close I beg to be excused for having chosen this vast and intricate subject, deserving of much better treatment, for my address to this learned gathering and for placing these rather unfamiliar concepts. It is hoped, however, that this will serve to focus the attention of all unbiased thinkers of the Geo-Sciences on this neglected aspect of geological thought and thus help in the correct understanding of the Crustal Evolution which is their ultimate goal.

I thank you again for the patient hearing.

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Note :—In Plate 3 (lower half) illustrating Crustal Evolution, the continental portions above the sea-level should be considered to include sedimentary formations as well.

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SECTION OF BOTANY

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PRESIDENTIAL ADDRESS

SOME ASPECTS OF THE STUDY OF PACHYTENE CHROMOSOMES

I feel honoured by being chosen to preside over the deliberations of the Botany section of the 49th session of the Indian Science Congress and I have great pleasure in tendering my sincere thanks to the Sectional Committee for electing me to this office. I also take this opportunity to express my gratitude to my distinguished teachers, Prof. D. G. Catcheside, D.Sc., F.R.S. and Dr. A. C. Joshi, D.Sc., F.N.I., to whom I owe my training in research. I am equally indebted to another distinguished botanist, Prof. P. Maheshwari, D.Sc., F.N.I., from whom I received advice and encouragement in many ways over many years.

I have chosen for the subject of my address "Some aspects of the study of pachytene chromosomes" because of my interest in the morphology and behaviour of chromosomes at the pachytene stage of meiosis. At prophase of meiosis-I the choromosomes are in their most attenuated form and lend themselves to be seen in minute detail under the microscope such as is not revealed at other stages of their mitotic and meiotic cycle except in the case of the salivary gland chromosomes of Diptera to which the famous fruit fly, *Drosophila melanogaster,* belongs. It is in this phase of meiosis that homologous chromosomes come together in pairs and the paired chromosomes become self duplicated and, through as yet not precisely understood forces, undergo transverse breaks at corresponding levels along their length followed by reunion of broken ends. When the reunion involves non-sister chromatids, it leads to cross-over and recombination phenomena which form the corner stone of the edifice of variation, heredity and evolution in sexually reproducing organisms.

Before considering pachytene chromosomes further, it is appropriate to review briefly the history and development of the study of chromosomes. More than a century ago, Hofmeister (1848) figured the chromosomes, although without appreciating their significance. It was actually in 1875 that Strasburger described these structures to which Waldeyer gave the name of chromosomes in 1888. In 1879, Flemming observed the longitudinal splitting of the chromosomes. Shortly thereafter, Van Beneden (1883) and Heuser (1884) showed in animals and plants respectively that the daughter halves pass to opposite poles in the anaphase. In the years from 1885 to 1887, Weismann published a theory of chromosome behaviour during cell division and fertilization which explained the earlier observations of Van Beneden, Strasburger, Hertwig and others. Weismann's prediction about the occurrence of reduction (meiosis) was promptly verified by Boveri (1887) and Strasburger (1888). The latter third of the 19th

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century was especially significant in the history of cytology and during this period striking advances were made by great investigators like Strasburger, Van Beneden, Hertwig, Boveri and others which became possible through development of magnifying apparatus of sufficient strength and resolving power not available before. At the end of the 19th century, cytology thus became established as a distinct science which, however, showed relatively little relationship to other sciences or other branches of biology.

The momentous rediscovery of Mendel's work was made simultaneously by De Vries, Tschermak and Correns in 1900. By this time the cytologists had independently demonstrated that the general history of the chromosomes during the life cycle runs so exactly parallel to that of Mendelian phenomena that both may in a large degree be formulated in the same terms. In the first few years after the discovery of the fundamental laws enunciated by Mendel, it was the work of Boveri (1902) and Sutton (1902, 1903) that had shown that the new laws are completely explained by the location of the unit factors, later called genes, in the chromosomes and by the manoeuvres of maternal and paternal chromosomes in the meiotic divisions. From this time onwards cytology developed a fruitful alliance with genetics. Nevertheless the synthesis of cytology and genetics did not take place at once which is, at least in part, due to the unfortunate circumstance that the champions of the science of genetics in its early history like Bateson, Johannsen and Correns were sceptic about chromosomes. As late as 1911, Johannsen said that the question of chromosomes as the presumed bearers of hereditary qualities seems to be an idle one and it was Bateson's slogan that genetics must do its work without taking notice of eventual carriers of Mendelian unit factors while Correns, who did not agree in this with Bateson, had always insisted that the decisive facts were the genetic ones which might find interesting but unnecessary confirmation from cytology (Darlington, 1937 ; Goldschmidt, 1950). During the second and third decades of the 20th century, the brilliant researches initiated on *Drosophila* genetics by a team of unique scholars under the leadership of T. H. Morgan resulted in the establishment of linkage groups paralleling the chromosome sets. This along with the discovery by Bridges of non-disjunction with complete parallelism of genetic and cytological facts, the establishment of correlation between sex determination and sex chromosomes by McClung, Wilson and Stevens, and Carother's demonstration of random assortment finally ended the period of discussion of the chromosome theory of heredity proving it beyond doubt. This period also witnessed the use of cross-over values in building up genetic maps of the chromosomes and the data consistently upheld that genes are the particulate bearers of the hereditary traits and that they are arranged in linear order on the chromosomes. The study of crossing-over as a tool of analysing the material basis of heredity was brought to a successful end by the addition of visible proof of chromosomal exchange when in maize (Creighton and McClintock, 1931) and *Drosophila* (Stern, 1931) the simultaneous use of genetic and structural markers made visible the actual result of crossing-over. It is in this period that McClintock (1930, 1931) discovered, using the technique of Belling's aceto-carmine method, that pachytene chromosomes could be studied advantageously and in such detail as is not possible at other stages of chromosome cycle and that a correlation of many genetical facts with chromosome structure may be made out clearly. Here should be mentioned also about the brilliant contributions and formulation of general principles which we owe to Darlington (1932, 1937) and which have played

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a significant role in bringing about a synthesis of facts of cytology and genetics and stimulating much fruitful research in this fascinating field of work.

Morphology of the Pachytene Chromosomes

It may be said that the study of the pachytene chromosomes really began with McClintock's discovery (1930, 31) that the chromosomes comprising the haploid complement of corn are individually recognisable from each other on the basis of (i) their relative lengths, (ii) distinctive chromomere patterns, (iii) deep staining knobs in characteristic positions, (iv) location of the centromeres (determining arm ratios) and (v) the deep staining chromomeres adjacent to the centric regions which are most clearly evident in aceto-carmine and aceto-orcein squash and smear preparations of pollen mother cells at the pachytene stage when the chromosomes are evident as parallel threads. Besides McClintock, Longley (1938, 39, 41), Rhoades (1950) and Venkateswarlu (1950) and others paid further attention to pachytene analysis in various strains of maize and a test of analysis of variance revealed good agreement in their observations and reliability of the criteria employed. Just about two decades ago, our knowledge of the pachytene chromosomes was limited to maize, maize relatives and *Antirrhinum* (Ernst, 1939). Since then the morphology of the pachytene chromosomes has been studied in some other plants* in many† of which it has been possible to identify individually each of the chromosomes in the haploid set.

Considering the observations made so far, pachytene chromosomes may be broadly classified as (i) the differentiated and (ii) the undifferentiated types. In the former category may be placed such plants as tomato and many Solanaceae, Eu-sorghums, *Coix aquatica, Plantago* and others. In these the chromosomes are characterized by distally placed lightly staining and proximal deeply staining segments described by Hyde (1953) as 'achromatic' and 'chromatic', regions respectively. Maize, teosinte, *Tripsacum,* rye, barley, *Agapanthus, Oryza* represent the undifferentiated type. In these there is a uniform distribution of the chromomeres along the chromosome. Some of these like maize and teosinte are characterized by the presence of prominent knobs in characteristic positions but there is no chromomeric pattern or size gradient while rye, barley, para-sorghums (*Sorghum intrans,* Garber, 1947 ; *S. purpureo-sericeum,* Reddi, 1958) and *Saintpaulia ioantha* (Ehrlich, 1960) show a chromomere size gradient from the proximal to distal ends of the chromosome arms. Differentiated and undifferentiated chromosomes may occur within the same genus (eg. *Sor-*

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* *Aloe* and *Paeonia tenuifolia* (Eberle, 1957a,,b); *Bellavalia romana* (Oehlkers and Eberle, 1957); *Oryza granulata* (Hu, 1960); *Ricinus communis* (Jakob, 1956); diploid *Solanum* hybrids (Wangenheim, 1957).

† Acanthaceae (Takizawa, 1957); Barley (Sarvella, Holmgren and Nilan, 1958); *Brassica* (Röbbelen, 1960); Compositae (Scherz, 1957); Gesneriaceae (Eberle, 1956); *Haplopappus gracillis* (Jackson, 1959) *Ipomoea carnea* (Venkateswarlu and Ramana, 1962); *Melilotus* (Shastry and Rangarao, 1961; *Mnesithea perforata* (Roy and Singh, 1958); *Nicandra physaloidts* (Venkateswarlu and Rao, 1962); *Oryza saliva* (Shastry, Rangarao and Misra, 1960); *O. spontanea* and *O. perennis* (Shastry, Das and Gopakumar, 1962); *Plantago* (Hyde, 1953); Rye (Lima-de-Faria, 1952); *Salvia* (Linnert, 1955); *Saintpaulia ioantha* (Ehrlich, 1960); several Solanaceae (Gottschalk, 1954); tuberous *Solanum* (Gottschalk and Peters, 1956); diploid *Solanum nigrum* (Venkateswarlu and Murty, 1962); *Sorghum intrans* (Garber, 1947); *Sorghum subglabrescens* (Venkateswarlu and Reddy, 1956); *Sorghum purpureo-sericeum* (Reddy, 1958); *Sorghum ankolib* (Magoon and Shambhulingappa, 1960); tomato (Barton, 1950; Gottschalk, 1951).

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ghum) or even within races of the same species (*Coix lachryma jobi,* Venkateswarlu, 1960, 1961).

Length of the chromosomes : Due to processes of condensation, the length of each of the chromosomes during the prophase of meiosis decreases progressively and therefore the measurements of the length are to be made at the mid-prophase, which is the most stable stage of the prophase. Length alone does not offer an entirely satisfactory criterion for identifying the different chromosomes of the complement with certainty as there is much to suggest that the process of contraction may not take place simultaneously in all chromosomes or even in different sections of the same chromosome. To reduce errors on this score, it is necessary to have large number of measurements preferably based on complete analysis of nuclei to build up relative lengths for employment in the identification of individual chromosomes in a complement as well as for comparative purposes. Absolute lengths and total chromatin lengths, however, have their own value in evolutionary studies inspite of limitations.

Centromere and arm ratio : Centromere, also known as 'Kinetochore' and 'Spindle attachment fibre', is an indispensable portion of the chromosome. In most organisms it is localized and occupies a constant position relative to the ends of the chromosomes. In maize it has been described as a round or ovoid body, non-staining and structureless and somewhat larger in diameter than the remainder of the chromosome. In recent years, Lima-de-Faria (1956, 1958), made detailed observations on the centromere in a number of plants including maize and came to the conclusion that the fundamental pattern of the centromere consists of three zones each with a compound structure. The exterior zone is the least conspicuous and the median zone the most conspicuous of the three. Each zone was found to be composed of chromomeres or fibrillae or both.

The position of the centromere determines the arm ratio, a useful criterion in the identification of individual chromosomes in the haploid complement. In all plants examined, however, the centromeres are not sharply differentiated (Eg. *Lilium paradalinum,* Belling, 1928 ; *Sorghum intrans,* Garber, 1947 ; *Hordeum vulgare,* Sarvella et al., 1958 ; *Oryza sativa,* Yao et al, 1958) and in all such cases the lengths of the two arms cannot be measured accurately and other morphological criteria have to be relied upon.

Chromomeres : Chromosomes, particularly in the attenuated state of early meiotic prophase have a granulated appearance and each of them has the appearance of a string of unequal beads placed at unequal distances from each other. The beads are the chromomeres. Structurally they have been interpreted as different from the remainder of the chromonema because of a "distinct reactivity of their own in nucleic acid synthesis" (Pontecorvo, 1944 ; Kaufmann, 1948). On the other hand, Ris (1945, 1957) maintains that they represent gyres of new coils. However, they are constant in size and position at the pachytene stage and a good use of them can be made as land marks for identification of the different chromosomes. Long ago, Belling (1928) showed the possibility of analysing the pachytene chromosomes in a few plants including *Lilium paradalinum* in which he estimated that there are about 1500-2500 chromomeres on the whole chromosome set. In more recent years, Lima-de-Faria (1952) made a detailed study of the pachytene chromosomes and constructed chromomere maps for the different chromosomes and the "Standard fragment" in rye. His studies revealed a distinct chromomere pattern and chromomere size gradient

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which he made use of in the identification of the different chromosomes in the complement. Likewise, Reddi (1958) and Ehrlich (1960) were able to employ this criterion in the identification of the chromosomes in *Sorghum purpureo-sericeum* and *Saintpaulia ioantha* respectively while Gottschalk and his associates (Gottschalk, 1951, 1954, Gottschalk and Peters, 1956) used the number, size and position of the macro-chromomeres in the heterochromatic sections of the pachytene chromosomes in the identification of different chromosome types in their comparative studies on a number of Solanaceae.

Knobs : Pachytene chromosomes of certain organisms are characterized by the occurrence of knobs in terminal (Eg. *Tripsacum,* rye) or intercalary or both positions (maize, teosinte). In maize they are described as pycnotic swellings. In rye they occur in terminal positions and Lima-de-Faria (1952) described them as seriations of large chromomeres and deeply stained fibrillae. Knobs are distinguishable from chromomeres not merely by their size but also by the characteristic positions at which they occur. In maize there are no knobs near the centromere in the A chromosomes. Longley's studies in several strains of maize and teosinte (Longley, 1938, 1941) indicate that there is a point on the chromosome most favourable for knob formation and the knob building power of a knob forming point decreases as its distance from the most favourable point increases. In maize knobs are restricted to 22 different positions in all. Some strains show noknogs while in others upto a maximum of 16 have been reported. The size of the knob at the same position in different strains may vary. When a particular knob is present on a certain chromosome it is a constant feature of that chromosome and its inheritance is as precise as that of a mutant gene. As such knobs serve as useful morphological characteristics for identification of particular chromosomes in a haploid set (Longley, 1941 a, b). A study of the knobs was made use of in tracing relationships of maize with its relatives, in establishing relationships among cultivated varieties of corn and in providing clues regarding their geographical origin (Longley, 1938 ; Ibrahim, 1960) and also for considering the relationship of knob number and agronomic and morphological characters (Brown, 1949 ; Vachhani, 1950 ; Ibrahim, 1960 ; Wellhausen and Creslawa Prywer, 1954).

Nucleolus organizing chromosomes : Pachytene analysis has revealed that one or two chromosomes in the complement are concerned in the organization of the nucleolus and these can be readily identified by their evident attachment to the nucleolus in the meiotic prophase. In maize there is only one such chromosome (Chromosome-6) in the haploid complement and the nucleolus organizing region is in the form of a prominent deep staining some what reticulate body situated subterminally on the short arm while in *Tripsacum dactyloides* there are two nucleolus organizing chromosomes (Weatherwax and Randolph, 1955).

Sphaerosome : Recently Sarvella (1961) found peculiar button like bodies referred to as 'Sphaerosomes' at the ends of the chromosomes and also interstitially in *Gossypium herbaceum* and a few other plants but little is as yet known about their nature and significance or value as a diagnostic feature.

B-Chromosomes : Most of the above features refer to the morphology of the normal chromosomes of the complement referred to as A-chromosomes. In maize, rye, *Sorghum* (Reddi, 1958), *Pennisetum* (Pantulu, 1960) and several other plants, it is now well known that supernumerary chromosomes occur in some strains which Randolph has designated as B-chromosomes. The B-chromosomes in some of them have been studied at the

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pachytene stage. In maize, McClintock (1933) found that it is half as long as the shortest A-chromosome (chromosome 10) of the complement and has a minute short arm which is so minute as to make the centromere seem to be terminal. The long arm shows (i) a heteropycnotic body resembling the knobs on the A-chromosomes, (ii) a lighter staining region consisting of several small but distinct chromomeres, (iii) an elongated heteropycnotic region with several constrictions, (v) a bulging heteropycnotic region and (v) a broken heteropycnotic segment composed of four distinct parts proceeding from its proximal end to the distal. From the pairing behaviour as well as from morphological considerations it appears to possess no portion homologous with any region of the other ten haploid chromosomes. The B-chromosomes in *Tradescantia* are entirely euchromatic while in some others they are largely heterochromatic. Smaller sized derived types of chromosomes designated by Randolph as C, D, E and F chromosomes are produced through losses of segments of B-chromosomes and these differ from each other in their size and morphology (Weatherwax and Randolph, 1955).

Pairing Behaviour of the Pachytene Chromosomes

Pairing is generally believed to begin in the zygotene stage during which, in a normal diploid, two homologous chromosomes come together initially at specific points which may be at the ends or at the centric regions or may be distributed at random all along the length of the chromosome as the case may be in various species. When once the pairing is initiated, it spreads from the initial points in a zipper-like manner along the chromosome. The pairing is followed by chiasma formation and in several organisms these lie in the paired regions at random along the length of the chromosome. In certain organisms such as tomato (Brown, 1949 ; Barton, 1950), *Oenothera* (Marquardt, 1937), *Plantago,* (Hyde, 1953) in which the pachytene chromosomes are differentiated into proximal chromatic and distal achromatic regions, the chiasmata are formed in the distal achromatic regions. Thus there seems to be a relation between chromosome differentiation and chiasma formation. In these latter cases, absence of cross-over in the chromatic regions results in a total linkage of these regions which probably forms a mechanism for transmission of large blocks of hereditary material from generation to generation (Barton, 1950) without recombination, within themselves, but instead the material in these may be subject only to variation through mutation. Here may be mentioned about the recent work of Linnert (1955) who made a study of the relation of chromosome morphology to chiasma formation in eleven species of *Salvia* in which the pachytene chromosomes show differentiation into chromatic and achromatic regions to varying degrees. In all except one species, the chiasmata were formed in the achromatic regions, the localized position being constant for each species. The average number of chiasmata is constant for each chromosome and therefore the number of chiasmata was proportional to the number of chromosomes and also the chiasma frequency was inversely proportional to the extent of the chromatic segments. In *S. nemorosa,* however, the larger number of chiasmata occurred within the chromatic segments.

McClintock (1933) studied pairing at pachytene in normal, aneuploid and structurally dissimilar plants of corn. She found that while, as a rule, pairing takes place between homologous chromosomes or homologous parts of chromosomes wherever they are available, the prevailing tendency is for all parts of chromosomes to be associated 2-by-2 regardless of homology

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and that non-homologous pairing takes place in unbalanced types and structural heterozygotes, if homologous parts are not present or are not immediately available whether or not this is followed by chiasma formation. In plants heterozygous for inversion, translocation, deficiency, homologous pairing and 2-by-2 association are usually achieved by loop formation and cross shaped and more complicated configurations respectively while in heterozygous plants for duplication or deficiency a buckle is formed where the partner has no homologous segment. By and large, the occurrence of pairing followed by crossing-over and free gene exchange serves as an index of homology and provides valuable evidence regarding affinity between the chromosomal sets of different taxonomic entities. On the other hand, synapsis may fail even in pure lines and narrow crosses because of certain mutant genes influencing the course of meiosis or because of temporary physiological conditions.

Pairing in hybrids : A careful and detailed study of the pairing in intraspecific, interspecific and intergeneric hybrids is capable of yielding much valuable information about relationships, possibility of transfer of blocks of genes from one species into another and back-ground of sterility.

Only a few hybrids have been cytologically analysed at the pachytene stage. The earliest and more well known of these are those involving *Euchlaena* (teosinte), *Tripsacum* (gama grass) and *Zea* (maize). As early as 1932, Beadle analysed the pachytene pairing in maize-teosinte hybrids and this was followed by Longley (1937), and O'mara (1942). Longley found in hybrids between maize and annual mexican teosinte or teosinte from northern Gautemala a nearly perfect syanpsis of the *Euchlaena* and maize chromosomes at the pachytene followed by cross-over while in hybrids between maize and southern Gautemalan teosinte there were a few abnormalities due to differences in the linear arrangement of the homologous elements. O'mara compared the pachytene configurations of *Euchlaena* varieties—Florida, Moyutu and Nojoya—in crosses with each other and with maize. Florida and Moyutu in crosses with Nojoya and maize show abnormal pachytenes due to failure of certain chromosomes to pair normally. On the other hand, Nojoya-maize hybrids have normal chromosome pairing and cross-over frequency in the short arm of chromosome 9 is normal (O'mara, 1942). These comparisons indicate that Nojoya teosinte from northern Gautemala is in an intermediate position between teosintes from southern Gautemala and maize. In crosses between maize and teosinte, the resulting hybrids vary in fertility depending in part on what race of teosinte is used. In subsequent generations some of the plants show various parental combinations while others are precisely like maize or teosinte. In maize-gama grass hybrids and teosinte-gama grass hybrids synapsis occurs only in a few regions of the chromosomes indicating a low degree of homology. Although no pachytene analysis has been made, the hybrids involving all three genera (*Euchlaena, Tripsacum* and *Zea*) and F_1 hybrids of *Zea* ($n=10$) diploid × *Tripsacum dactyloides* ($n=18$) and *Zea* ($n=10$) × tetraploid *Tripsacum dactyloides* ($n=36$) are of interest in this connection (Mangelsdorf and Reeves, 1939). In the trigeneric and trigenomic hybrid (*Zea* × *Tripsacum* × *Euchlaena*), *Zea* and *Euchlaena* chromosomes pair leaving *Tripsacum* chromosomes unpaired except for an occasional trivalent. The F_1 hybrids of *Zea* ($n=10$) × *Tripsacum dactyloides* ($n=18$) have 28 chromosomes while the hybrids of *Zea* ($n=10$) × *Tripsacum dactyloides* ($n=36$) have 46 chromosomes. In the first case the chromosomes show no synaptic affinity and are present as 28 unpaired chromosomes in meiosis but in the second one, there are 18 bivalents obviously formed by the 36 *Tripsacum* chromosomes and 10 chromosomes

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(*Zea*) are left as univalents. The pairing reflects the relationship of the genera involved.

Hadley and Mahan (1956) observed pachytene pairing to be normal in 20 chromosome plants obtained from a back cross of 30 chromosome hybrid of *Sorghum vulgare* ($2n=20$ × *S. halepense* ($2n=40$), Johnson grass, with *Sorghum vulgare*. Based on their results the authors see a possibility for the transfer of segments from Johnson grass chromosomes to Sudan grass (*S. vulgare*) chromosomes and ultimately into Kafir grass (*S. vulgare*) and for the future establishment of perennial types which will be more easily established on the 40-chromosome level.

Gottschalk and Peters (1956a) made a study of the pairing behaviour of the pachytene chromosomes in a hybrid obtained from a cross between the tetraploid species of *Solanum ajuscoense* ($n=24$) and its diploid relative *S. stenotomum*. The chromosomes showed different amount of pairing within the genome and formed heteromorphic bivalents which could be classified into 9 pairing types. In each of them the homologous regions showed a side by side pairing while the non-homologous regions were left out as loops. In eight of the nine types the non-homologous parts were situated in the chromatic regions while in the ninth type it was in the achromatic part bordering on the chromatic segment. In spite of the differences revealed in the homology of the pairing chromosomes at the pachytene stage, the diakinesis and metaphase configurations were quite normal. In species hybrids in the genus *Gossypium*, Brown (1958) found the pachytene pairing to be as close in sterile species hybrids with reduced metaphase associations as in fertile species hybrids with good metaphase pairing and as in the parents and concluded that either pachytene pairing is no measure of structural differentiation of chromosomes or factors other than structural differences are responsible for reduction in chiasma formation and metaphase association. On the other hand Wangenheim (1957) reported regular pairing at the pachytene, metaphase—I and regular segregation at anaphase—I stages of the meiosis in species hybrids of *Solanum* and found in crosses involving *S. simplicifolium* as mother that sterility was due to cytoplasmic causes. All these studies point to the conclusion that one cannot afford to neglect study of any of the stages in meiosis for arriving at completely valid conclusions regarding the causes of sterility in hybrids. Recently Shastry and his collaborators at the I.A.R.I., Delhi, have succeeded in completely analysing the chromosome complement of *Oryza* species and subspecific hybrids at the pachytene stage. The pachytene analysis carried out by Shastry and Misra (1961) in four japonica-indica hybrids has uncovered the presence of inversions, translocations, deletions and differential segments showing structural hybridity to be responsible for the sterility in these hybrids rather than genic causes as supposed by earlier workers (Oka, 1957 ; Hsieh and Oka, 1958).

Pairing in haploids, autopolyploids, polysomics and hyperploids: In haploids, due to absence of homologous chromosomes in the genome, there will be no pairing of chromosomes at meiosis and the chromosomes become segregated at random resulting in sterility. A functional gamete may be formed occasionally, on a random basis of segregation, the probability of obtaining a fertile gamete being $\frac{1}{2}^{n}$, where n is equal to the number of chromosomes in the haploid genome. McClintock (1933), in monoploid plants of maize, found non-homologous pairing between two parts of the chromosome as a fold back as also between two different chromosomes. However, the association did not persist upto diakinesis and metaphase. In certain organisms bivalent formation was found in haploid

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nuclei which is suggestive of a basic number lower than that of the haploid number or otherwise presence of duplications. Very recently, Rieger (1957) made a detailed study of the pachytene in haploid *Antirrhinum majus* ($n=8$) which revealed a high degree of pairing between non-homologous or partially homologous chromosomes ranging from formation of four bivalents to no pairing and occurrence of trivalent and more complex configurations and fold backs involving a whole chromosome or of chromosome segments. From the observations it was concluded that at least one intra-chromosomal and one inter-chromosomal duplication were present and that the latter causes preferential pairing of two specific chromosomes.

Pairing at the pachytene has been studied in rather few polyploids obviously due to the difficulty of following chromosomes at this stage from end to end. Newton and Darlington (1929) and Darlington (1929) arrived at very significant conclusions based on their study of pachytene pairing in triploid and pentaploid tulips and triploid and aneuploid hyacinths. Besides the above only a few other polyploids such as *Antirrhinum* (Straub, 1939), *Impatiens* (Bole and Straub, 1942), *Streptocarpus* (Oehlkers, 1942), *Digitalis* (Linnert, 1949) and in tetraploid species of tuberous Solanums (Gottschalk and Peters, 1956b) have been investigated. An extensive and detailed study of pairing at the pachytene with reference to particular chromosomes of the complement in autotertaploid maize on a quantitative basis was carried out by me some time ago (Venkateswarlu, 1950) and more recently by Gottschalk (1955) in autotetraploid tomato. Maize differs from tomato and most other plants listed above in having undifferentiated chromosomes.

Based on their studies in tulips and hyacinths, Newton and Darlington and Darlington suggested that there are two phases in the process of pairing, an earlier phase in which there is a generalised attraction among all the three or four or more homologues as the case may be and a second phase in which the attraction is between any two of them at any particular point along the length of the chromosome so that the whole chromosome does not act as a unit and the affinities of the chromosomes are satisfied by association in twos. An unpaired particle is largely influenced in its choice of a partner by the pairing of adjoining particles so much so the particles lying in a block of the chromosome act as a unit designated as "pairing block" and these pairing blocks are distributed at random as associations of twos. These associations spread along the length of the chromosome and where two associations having only one chromosome in common run into each other, they exchange partners. For multivalent formation, the two prerequisites are : (i) the exchange of partners and (ii) formation of chiasmata in appropriate places and appropriate number. (See diagram).

A study of nearly 200 pachytene associations representing all the chromosomes in the complement in (autotetraploid) maize (Venkateswarlu, 1950) revealed that the exchanges ranged from none to two. In tulips and hyacinths as many as six exchanges were observed (Darlington, 1937) while in the autotetraploid tomato they varied from none to one (Gottschalk, 1955). The occurrence of quadrivalent type 14 was reported long ago by Upcott (1935) in autotetraploid tomato and this would require occurrence of at least two exchanges, one in either arm of the chromosome concerned in the pachytene configuration and suggests that in tomato also occurrence of more than one exchange is to be expected at least rarely. The number of pairing blocks would be one more than the number of exchanges observed in an association of four homologues. The data obtained

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in maize reveal that (i) the mean number of pairing blocks increases with the increase in the length of the chromosome upto a certain limit beyond which it decreases and (ii) that the mean length of the pairing block increases with the length of the chromosome (except in chromosome—6 where it is not so sharp probably due to its special features). These conclusions are also borne out by the inferences drawn by Darlington and Mather (1932) and Stone and Mather (1932) on the basis of a study of diakinesis and metaphase configurations in triploid tulips and hyacinths.

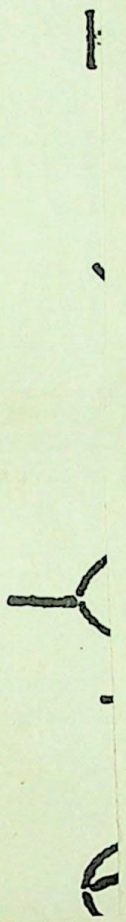
The initial points of pairing, as inferred from the positions of the exchanges of partners in maize, are distributed at random all along the length of the chromosome. The data on chromosomes 6 and 9, however, indicate that the initial points tend to show preferentially higher frequencies of occurrence in the regions including the knobs in the former and in the proximal and distal regions in the latter. Just as in maize, there is the general tendency of random distribution of the initial points of pairing in *Solanum andigenum* and *S. tuberosum* (Peters, 1954) while in autotetraploid tomato (Gottschalk, 1955) the initial points of pairing seem to lie in the heterochromatic proximal segments as indicated by the localization of the exchanges of partners in centromere region. This seems to be generally the situation in organisms such as *Digitalis, Antirrhinum, Impatiens* and *Streptocarpus* all of which share with tomato the character of differentiated chromosomes. Thus there seems to be a relation between the morphology of the chromosome and the position of exchange of partners as well as the initial points of pairing.

In maize, in addition to the 2-by-2 pairing association of the four homologues of particular chromosomes of the complement, in an appreciable number of cases (80 out of 195 observed), all the four homologous centromeres of a group of four, are associated together with or without an exchange of partners elsewhere. Unless these are also taken as representing partner exchanges, occurring in the centromere region, the multivalent proportions realised at diakinesis and metaphase stages are not accountable.

So far pairing behaviour of the pachytene chromosomes has been studied only in polysomics of maize and tomato. McClintock examined the different primary trisomics of maize to identify the triplicated chromosome and associated particular chromosomes with the ten different linkage groups. As in triploids, the three homologues of the triplicated chromosome show 2-by-2 pairing, different twos at different places along the length of the chromosome with exchange of partners whenever pairing blocks involving one common chromosome run into each other or two of the homologues form a pair bearing the third one unpaired. The latter sometimes shows fold back pairing. Judging from the configurations realised at diakinesis and metaphase the exchanges range from none to two depending on the length of the chromosome concerned. McClintock (1933) reported non-homologous pairing also in 2n+1 plants for chromosomes 7, 8, 9 and 10 and in 2n+1B chromosome maize plants. Emmerling (1958), in 2n+1 trisomics for chromosome 10, the triplicated set including one abnormal 10, reported homologous pairing of the short arms of two homologues and non-homologous association of the short arm of the third homologue with a part of the long arm of one of the homologues. Partly the long arm showed homologous pairing and the unpaired part showed a fold back configuration. There were also configurations of pairing between two homologues all along their length leaving a third one the short arm of which was synapsed with itself. Earlier, Rick and Barton (1954) studied the pachytene and identified with certainty the chromo-

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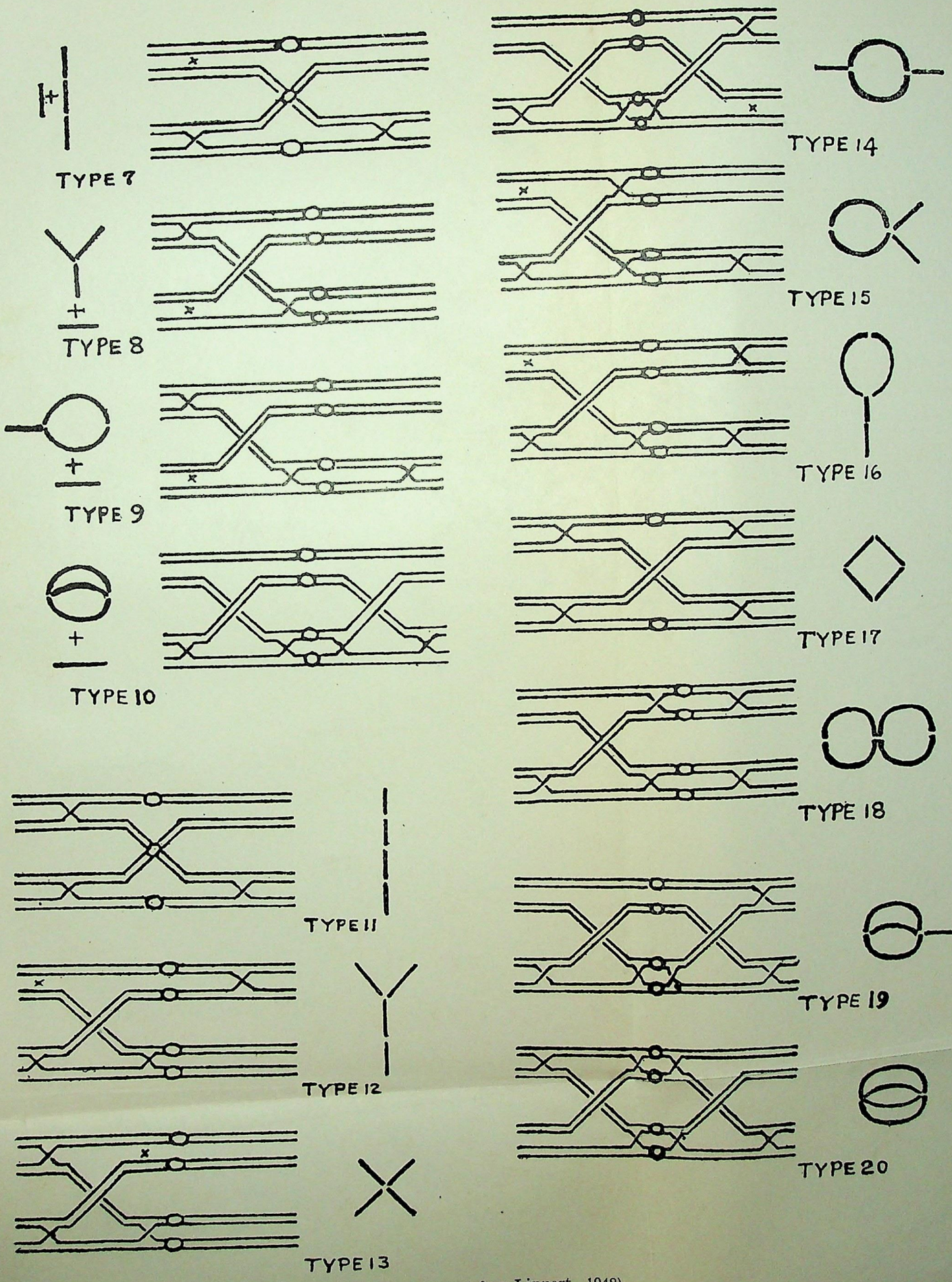


DIAGRAM (after Linnert, 1948)

Diagram showing the minimum number of exchanges of partners and their distribution and the minimum number of chiasmata and their distribution required for the formation of the various types of multivalents at diakinesis. The diakinesis configurations with type numbers assigned to them by Darlington are also given side by side with these.

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some concerned in 11 out of the possible 12 primary trisomics in tomato. Their text figures indicate that the pairing of one of the homologues with the rest of the other two in the triplicated set can be at any place along the length of the chromosome. The greater the length of the chromosome the greater is the tendency for it to form trivalents. Similar positive correlation between the length of the chromosome and proportion of trivalent pairing was also reported by Einset (1943) in the different primary trisomics of maize. Rhoades (1933, 1955) studied pairing at the pachytene in secondary trisomic of triplo 5 of maize and established that the third chromosome concerned is the iso-chromosome formed from the short arm of chromosome 5. Two types of configurations were found. In the first one the distal parts of each arm of the iso-chromosome paired with the corresponding distal parts of the short arm of two normal chromosomes giving rise to a cross-shaped pachytene configuration leading to the formation of a ring of three at diakinesis when the necessary partner exchanges and chiasmata at appropriate places are formed. In the second type, the iso-chromosome is not paired with the normal chromosome 5, but its two homologous arms are synapsed with each other producing a configuration with the median centromere in a terminal position. This latter category leads to the formation of a bivalent *plus* a closed univalent or circlet. Emmerling (1958), in a secondary trisomic of maize chromosome 10 with two normal chromosomes 10 (one with knob and the other knobless) and iso-chromosome for the long arm of knobbed chromosome 10 recorded partial pairing between the two arms of the iso-chromosome, pairing of each arm of iso-chromosome with each of the two long arms of the normal knobbed and knobless chromosomes 10, together with pairing of the short arms of the knobbed and knobless chromosomes.

Rhoades (1940) also studied pachytene pairing in hyperploid *Zea* 2n+1 telocentric fragment consisting only of the short arm of chromosome 5 and found that the three homologous arms of this chromosome paired with each other, two at a time at different places and showed one or two exchanges of partners. For a part of the length, one of the three arms was left unpaired.

More recently, Maguire (1957) investigated knob bearing *Zea* hyperploid for a *Tripsacum* chromosome (2*n Zea* complement *plus* 1 *Tripsacum* chromosome with terminal knob) and made some interesting observations. The knob bearing end of the *Tripsacum* chromosome paired with the short arm of one particular *Zea* chromosome 2 and its other portion including the centromere paired with the short arm of the second *Zea* chromosome 2, while the long arms of the two *Zea* chromosomes 2 paired with each other producing a Y-shaped configuration. The cytological and genetical observations indicate that the pairing between the knob end of the *Tripsacum* chromosome and the short arm of one particular *Zea* chromosome 2 is homologous while the pairing between its other end and the short arm of the second *Zea* chromosome 2 is non-homologous. Also the short arms of the Zea chromosome 2 paired with each other only in the absence of the *Tripsacum* chromosome. There was high trivalent frequency in the hyperploid plant involving non-random pairing of the *Tripsacum* chromosome and one particular *Zea* chromosome 2 and this was explained on the basis that in an earlier generation an exchange of material occurred between one of the *Zea* chromosomes 2 and the *Tripsacum* chromosome involving segments which make the short arm of the former more homologous with that of the latter than with the other *Zea* chromosome 2. Further the terminal knob of the *Tripsacum* chromosome appeared occasionally transferred to the end of the short arm of Zea chromosome 2 by some mechanism other than

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normal crossing-over. This sort of a shift of knob is comparable to the shifts in position of chromosome segments or genes postulated by McClintock (1950, 51, 52), Brink and Nilan (1952) and Barclay and Brink (1954) to explain certain characteristics of mutable loci and to genetic transfer without crossing-over (Mitchell, 1955a, b). Later Maguire (1960a, b) studied pachytene and metaphase configurations in 2n *plus* 1 maize plants of two types: (i) knob (+) plants in which the triplicated set consists of two reciprocal interchange Zea-Tripsacum chromosomes, one with a terminal knob *plus* a normal Zea chromosome 2 and (ii) knob (−) plants in which the triplicated set consists of two normal chromosomes 2+one reciprocal interchange *Zea-Tripsacum* chromosome. Trivalent frequency both at the pachytene and metaphase I was very high (90% and above) in knob (+) plants and much lower (about 65%) in knob (−) plants. The knob bearing segment thus seems to exercise influence on the pachytene pairing followed by chiasma formation indicating high cross-over frequency.

Pachytene Chromosomes and Cytogenetics

In the building up of the exceptionally high place that cytogenetics occupies to-day as a result of the combined efforts of the two disciplines of cytology and genetics, pachytene chromosomes have played a tremendously significant role and indeed the pachytene maps of maize and salivary gland chromosome analysis in *Drosophila* are the outstanding monuments to this effort. Maize admirably fulfils the prerequisites of suitability of the organism for both genetic study and chromosome analysis at the pachytene stage as no other organism does. Further, Randolph (1948) and Wellwood and Randolph (1957) have shown that the clumped versus well spread character of the pachytene configurations is under the control of genes (more than one) and this makes it possible to obtain stocks with well spread character of pachytene configuration in projects involving their analysis as has been done by Maguire (1960a) in her recent studies on maize hyperploids for *Tripsacum* chromosome. In recent years, pachytene studies correlated with genetic data have also been begun in tomato where eleven of the twelve linkage groups have been associated with their respective chromosomes (Rick and Barton, 1954). *Antirrhinum* is still another plant similarly suited for pachytene studies and genetic analysis.

All our cytogenetic knowledge based on pachytene studies comes solely from maize which has yielded information for elucidation of fundamental genetic and cytogenetic principles more than any other single plant. Maize cytogenetics received an impetus with McClintock's discovery (1930) of the possibility of identifying individually each chromosome of the haploid complement. It was shown that the numerous genetic characters described in maize fall into ten linkage groups in correspondence with the haploid number of chromosomes and that each of them is associated with a specific chromosome. The identification of the pachytene chromosomes and their association with specific linkage groups came almost entirely from McClintock's brilliant and illuminating studies. She continues to make remarkable contributions, through studies on maize, to our cytogenetic knowledge. The most recent of these relate to the breakage-fusion-bridge and breakage-fusion cycles which she has made a major field of investigation. Her investigations on break-fusion cycle led to the particularly interesting discovery and elucidation of Dissociation-Activator system (Ds−Ac) the studies on which demonstrate that genic expreession is intimately related to chromosomal organization. The system consists of two chromosomal units believed to be heterochromatic in nature. They function

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and become recognizable only through their action on other genes and loci and their location in the chromosomal complement can be determined by linkage studies. They can move in the chromosomes from one location to another and are capable of entering or leaving the chromosome complement at any position. McClintock designated this phenomenon as "Transposition". Ds has a standard position on chromosome 9 but Ac has no such position. When transposition of Ds takes place a break appears at the position it leaves coincidentally with its transposition to another place. In the absence of Ac in the nucleus, Ds is ineffective but is unstable in its presence, so much so Ac acts as a master locus. The presence of both units in the same nucleus gives rise to an increase in spontaneous breaks and unstable and mutable loci. Ds has a double function in the presence of Ac. It is the site of breakability and it affects genes adjacent to it. For instance the gene Wx behaves as if it is mutated to a recessive condition and removal of Ds from its neighbourhood restores it to its normal state. Besides McClintock, Anderson, Beadle, Brink, Burnham, Clark, Cleveland, Cooper, Creighton, Darlington, Emerson, Longley, Morgan, Randolph, Rhoades, Stadler and others have made outstanding contributions which form the basis of present day cytogenetic concepts. As it will occupy much time and space and as also these have become incorporated in text books on cytogenetics or reviewed in detail from time to time by Rhoades and McClintock (1935), Longley (1952) and Rhoades (1955), no attempt is made to present details here. I shall content myself by giving here some of the results obtained in the cytogenetic studies. These are :

1. The placement of many of the known genes into ten linkage groups corresponding to the ten morphologically identifiable chromosomes of the haploid complement. This was done first through the cytogenetic study of the different primary trisomics and by the time six of the linkage groups 2, 3, 5, 6, 7 and 10) were associated with their respective chromosomes, two other methods namely that of using translocations and deficiencies also became available furnishing a means of checking the old determinations as well as associating the rest of the linkage groups (1, 4, 8 and 9) with their respective chromosomes.
2. Location of the specific genes at definite points within the physical chromosome.

For this translocations have been widely employed. Other aberrations like deficiencies, duplications and inversions have also been used effectively.

Centromeres have been located by the use of cytogenetic data from translocations (Anderson and Randolph, 1945).

3. Cytological demonstration of crossing-over.
4. Cytological and genetical proof of chromatid crossing-over (usual non-sister chromatid crossing-over).
5. Occurrence of sister strand crossing-over.
6. Cytological demonstration of the physical location within the chromosomes of reciprocal translocations, inversions and deletions.
7. Reduction of normal crossing-over resulting from non-homologous association and reduction of amount of crossing-over for loci located in inverted segments.
8. Relationship between semi-sterility and reciprocal translocations and the importance of different sectors of the chromosome to viability of gametes by means of haplo-viable and haplo-inviable deficiencies.
9. Ability of parts of broken centromeres to function in the spindle figure.
10. Break-fusion-bridge cycle and behaviour of ring chromosomes in mitosis leading to aberrations.
11. Break-fusion cycle, "Transposition" phenomenon, discovery of the Dissociation-Activator system and probability of special genetic role of heterochromatin.
12. Non-disjunction of B-centromere bearing interchange chromosome between A- and B-type chromosomes at 2nd division of the microspore nuclei and directed fertilization.
13. Presence of abnormal 10 results in preferential segregation in megasporogenesis and formation of neocentromeres (Secondary centromeres) not only in

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abnormal 10 itself but in other chromosomes heterozygous for knobs. This is believed to be due to a piece of chromatin foreign to the normal set being present in abnormal 10.

Recently, Emmerling (1958) found occurrence of non-disjunction of abnormal 10 and production of fragmented chromosomes by breakage of attenuated neocentric chromatid, two phenomena predicted earlier by Rhoades. At the same time Ting (1958) adduced evidence to the effect that abnormal 10 in maize has arisen as a consequence of simple translocation between A- and B-chromosomes.

Pachytene Chromosomes as an Aid in Phylogenetic and Evolutionary Studies

Chromosomes, being the vehicles of hereditary transmission from generation to generation, are the most likely to enlighten us not only about the ancestry and inter-relationships but also about the evolutionary processes at work and future possibilities in the evolution of a race or a group of organisms. The various criteria employed in such studies are the morphological features like absolute and relative lengths, arm ratios governing the symmetry and the pairing behaviour of the chromosomes at meiosis. The morphological features are more vividly seen in pachytene chromosomes than in somatic chromosomes and such additional features as chromomeric pattern, extent of euchromatic and heterochromatic segments, knobs and nucleolus organizing regions lend themselves to a more precise analysis at the pachytene in all such organisms amenable for study of the pachytene chromosomes. Especially such studies are necessary in organisms with very small chromosomes in which all these features are not clearly observable at mitosis. Pachytene studies are so far made only in a very few groups of plants and utilized in the understanding of phylogenetic relationships and evolutionary problems.

One of the most notable among the few is the group maydeae which includes maize and its relatives. Differences and similarities in the chromosome number, pachytene configurations and meiotic behaviour in hybrids involving the various members have been studied for the understanding of relationships and reconstructing evolutionary sequences. Almost all the information gathered relates to maize and the American maydeae and only recently some information has become available in Asiatic maydeae like *Coix lachryma-jobi* and *C. aquatica* (Venkateswarlu, 1960, 1961). The length range of the pachytene chromosomes within the complement is from $80\mu - 40\mu$ in maize ($n=10$) and *Euchlaena* ($n=10$), while in *Tripsacum* (*T. floridanum*, $n=18$), it is on average about half of that in corn, the longest chromosome being only as long as the shortest chromosome in corn. In *Coix aquatica* ($n=5$) the chromosomes are the longest in maydeae so far as known, the length range being 112μ to 70μ while in *C. lachryma-jobi* ($n=10$) it is about 85μ to 35μ which is somewhat near to maize. The chromosomes of maize, except chromosome 5, have submedian centromeres. Knobs are known to occur in 22 different loci, a few being terminal and others being intercalary. There is a single nucleolus organizing chromosome (Chromosome 6) with the organizer being nearly terminal in the short arm. *Euchlaena* is similar to maize in the above features. In *Tripsacum* the centromeres are subterminal in position. There is only one nucleolus organizing chromosome in *T. floridanum* which is acrocentric. There are two such in *T. dactyloides* ($n=36$) from Kansas, one being short and acrocentric while the other is metacentric. The nucleolus organizing bodies in both the species are near the centromere on each of the nucleolus organizing chromosomes (Weatherwax and Randolph, 1955). Knobs in *Tripsacum* are all terminal,

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but knobless species (*T. australe* and *T. maizar*) are known. In *Coix aquatica* ($n=5$) three of the five chromosomes of the haploid set have nearly median centromeres and the rest are submedian while in *C. lachryma-jobi,* their positions are more nearly as in maize. The species of *Coix,* so far as known, have terminal knobs, small in *C. aquatica* and conspicuous in *C. lachryma-jobi.* There is a single nucleolus organizing chromosome in the latter, the nucleolus organising body being nearly terminal as in maize while in *C. aquatica* there are two nucleolus organising chromosomes in the haploid complement of five. The chromosomes in some races of *C. lachryma-jobi, C. aquatica* and *Tripsacum* are differentiated, the arms being distinguishable into euchromatic and heterochromatic segments while in *Zea, Euchlaena* and some races of *C. lachryma-jobi,* they are undifferentiated. *Zea* and *Euchlaena* cross readily with each other than either with *Tripsacum. Zea-Euchlaena* hybrids are fertile with normal pairing behaviour and crossing-over, while in hybrids between *Tripsacum* and *Zea* or *Euchlaena* are not so. The greater homology of the chromosomes of *Zea* and *Euchlaena* than homology between either of them with those of *Tripsacum,* as revealed by the pairing behaviour in the meiosis of a trigeneric and trigenomic hybrid involving all three of them, has been referred to earlier. Considering all the above data together, *Zea* and *Euchlaena* undoubtedly appear to be more closely related to each other within maydeae and it has even been proposed that *Euchlaena* should be merged in the genus *Zea* (Reeves and Mangelsdorf, 1942). *Coix lachryma-jobi* is intermediate between *Zea* or *Euchlaena* and *Tripsacum* while *Coix aquatica* seems to be nearer to *Tripsacum* in having differentiated chromosomes and two nucleolus organizing chromosomes (as in *T. dactyloides* from Kansas) but different in the length range of chromosomes from the rest of maydeae.

Gottschalk (1954) made a detailed study of the morphology of the pachytene chromosomes in several Solanaceae and considered its bearing on the phylogeny of the family. He recognised various basic chromosome types and traced an evolution in them from the simple to the derived. On the basis of his observations on the differentiated or undifferentiated structures of the chromosomes, extent of heterochromatic and euchromatic segments, number of macro-chromomeres and degree of heterochromaticity, he arranged the various genera into graded series of complexity and classified the family into Nicandreae, Solaneae, Datureae, Cestrae and Salpiglossoideae. He holds that differentiated chromosomes represent the more advanced condition and considers that *Nicotiana* and *Cestrum* should be accorded an isolated position in the family and that the latter may be even excluded altogether from the family. Both these genera show undifferentiated chromosomes.

More recently, Röbbelen (1960), on the basis of detailed pachytene analysis in three species of *Brassica* (*B. campestris,* $n=10$; *B. oleracea,* $n=9$; *B. nigra,* $n=8$) and a few interspecific hybrids found that 6 chromosome types, designated as A B C D E F, recognised on the basis of total length, symmetry of the arms, and especially shape of the heterochromatic centromere region, are common to all of them but they were present in different numbers in the three species. The study showed that *B. campestris* is doubly tetrasomic for two chromosome types and hexasomic for another chromosome type (AABCDDE—FFF), *B. oleracea,* a triple tetrasomic (ABBCCDEEF) and *B. nigra,* a double tetrasomic (ABCDDEFF). Röbbelen's findings are supported by homologies revealed by secondary pairing in a triploid hybrid involving the genomes of *B. campestris* and *B. oleracea* and they confirm the presence of balanced

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secondary polyploidy in *Brassica* (derivable from the basic chromosome number, $x=6$) which seems to be operative in species differentiation within the genus.

Epilogue

Of all fields of biological enquiry, cytology, the study of the cell, comes nearest to the heart of the major quest of biology—the understanding of life in its essence. In this, the study of the chromosomes has been the major preoccupation of cytologists since a long time and their form, structure and behaviour have been studied in the cellular environment. We have progressed from the bare recognition of the nuclear outline in the cell to the formulation of the hypothesis that it is the seat of the hereditary units and to the precise statement that the genes occupy definite loci on chromosomes. The information obtained from pea, corn, fruit fly and *Neurospora* applies equally well from microbes to man. Recent studies indicate that the genic material constantly contains Deoxyribose Nucleic Acid (DNA) for which a complementary duplex structure is proposed and this structure has the power of self replication, a character of the genes and chromosomes. Further progress in the knowledge of their workings seems to rest on the understanding of the biophysical and biochemical aspects. It is already indicated that the gene is compound and that intragenic crossing-over takes place. In some of the lower organisms some thing corresponding to the genes and having Deoxyribose Nucleic Acid (DNA) or Ribose Nucleic Acid (RNA) is the sole representative of the conventional chromosome. Thus various important discoveries have been made with march of time and secrets of nature revealed. One may ask—can we ever have access to the ultimate unit of which the whole biologico-genetical panorama is a manifestation? Can we ever hope to uncover the face of Truth so as to have complete understanding of the mechanism of creation? Truth, the mystic poet says, is eternities away and we but climb in the dark of time to the dawn of day. Shall the dawn ever be espied? Science, philosophers say, approaches truth asymptotically, but let us hear, in all humility, to what the upanishadic seer says :

हिरण्मयेन पात्रेण	*Hiranmayena Patrena*
सत्यस्याऽपिहितम् मुखम् ।	*Satyasyapihitam Mukham,*
तत्त्वं पूषण्णपाकुरु	*Tatvam Pōōshannapakuru*
सत्य धर्माय दृष्टये ॥	*Satya Dharmaya Drishtaye.*

(इश, उप, 15) (Eesa. Upa. 15)

"The face of the real is covered up with a golden vessel. O' nourisher, uncover it for me who approaches it according to the law of Truth."

The upanishad here vouchsafes a vision of reality to an investigator who is himself in tune with reality, walking on the razor-edge path of Truth.

I have endeavoured to present the subject of my address in as interesting and scientific a manner as possible and I am conscious that several aspects have been left out, particularly the chemical aspect. The study

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of pachytene chromosomes has a wide scope and I will be more than gratified if my effort serves to enthuse younger workers in our country to pursue fundamental problems in this line of work. T. H. Morgan, one of the greatest geneticists, counselled that the way to making discoveries is "By industry, by trusting to luck for new openings, by the intelligent use of working hypotheses . . . . . by a search for favourable material, which is often more important than plodding along the well-trodden path hoping that something a little different may be found." This commends itself to all of us in our scientific pursuits.

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SECTION OF ZOOLOGY AND ENTOMOLOGY

President :—Dr. L. S. Ramaswami, D.Sc., F.Z.S.

PRESIDENTIAL ADDRESS

INDUCTION OF SPAWNING IN CATFISH AND FROG WITH HORMONES AND AN ACCOUNT OF THE CYTOCHEMISTRY OF THEIR PITUITARY GLANDS

CONTENTS

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9. Acknowledgment
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Mr. President, ladies and gentlemen :

I am deeply impressed with the honour you have done me in electing me the president of this session of Zoology and Entomology section of the Indian Science Congress. I appreciate it very much.

Introduction

I have chosen for my discussion with you this morning a branch of Animal Physiology which is sparsely pursued in Indian Universities with the pious hope that it will become more popular. The day is not far off when greater emphasis will be laid on general endocrinology as a handmaid to the teaching of vertebrate embryology or vertebrate-physiology in college classes.

We have been for sometime past examining the effect of hormones on the spawning behaviour of catfish and frogs and also the cytomorphology of the pituitary glands in these forms. I propose to give a resume of the work that we have done so far.

It is common knowledge now that in teleostean fish the gravid female can be made to spawn with injection(s) of homoplastic pituitary gland. Even those form like *Catla*, *Labeo* (rohu), *Cirrhina* (mrigal) which normally breed in suitable spawning grounds near flowing waters, are made to yield viable eggs with pituitary injections (Alikunhi *et al.* 1960).

The advantage of the hatchery method is, amongst others, that it provides pure seeds.

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Spawning of Catfish

With regard to the catfish and the frogs we have studied, viz., *Heteropneustes* (*Saccobranchus*) *fossilis*, *Clarias batrachus*, *Mystus* sp., and *Rana hexadactyla* Less. (the green-frog), *R. cyanophlyctis* Schn. (the skipper-frog) and *R. tigrina* Daud. (the bull-frog), the breeding season, like other aquatic vertebrates in and round Bangalore, S. India where most of these experiments were conducted, is during the monsoon season July-September ; while some lower vertebrates exhibit a second spawning season during the returning monsoon, the catfish do not.

During the height of the season, gravid *Heteropneustes* could be made to spawn with a parenteral injection of 1/16 homoplastic pituitary gland (Ramaswami and Lakshman 1959b). Fresh glands appear to be more effective than alcohol preserved or acetone dry powder. Holtfreter's standard solution was the medium in which the glands were homogenised and intramuscularly injected. Whether injected intramuscularly or intraperitoneally the effect was the same, but there was always the danger of damaging the gravid ovaries by the intraperitoneal method. With regard to cranial injections, it was rather difficult to insert the needle through the opening in the skull roof and we did not pursue this method. In all these experiments we have managed not to crowd the aquaria and to hold always a statistically significant number of animals for our experiments in suitable aquaria. Experiments have been replicated a number of times.

The effect of the pituitary gland injection becomes apparent after a lapse of 8-10 hours in the test animal when they start yielding viable eggs.

It has been possible to induce *Heteropneustes* to yield viable eggs 8-10 weeks ahead of the spawning season. During May-June, the catfish ovary is in stage 4 according to the maturity scale adopted by the International Council and the catfish requires a homoplastic pituitary gland or more for bringing about spawning (Sundararaj 1959) ; the pituitary gland of the catfish according to him shows the fewest number of granulated basophils. Hasler *et al.* (1939) and Kawamura and Otsuka (1950), amongst others, have also brought about spawning in advance of the spawning season in trout and goldfish respectively with pituitary gland injections.

It is not possible to bring about advance spawning in *Clarias*, a catfish which is closely related to *Heteropneustes* and lives in the same lake. *Clarias* reacted to pituitary injections favourably (Ramaswami and Sundararaj 1957d) only from the end of July onwards. It is noticed that this catfish requires two injections of two gravid homoplastic pituitary glands each at an interval of 24 hr. ; the first dose helps in priming up the ovary.

A large number of catfish fail to spawn and become eggbound. Such eggbound females are abundantly seen in catches during the post-spawning months November-December. During November according to Sundararaj (1959), the catfish pituitary gland shows the maximum number of basophils, a few of them showing degranulation also. In December, most of the basophils have degranulated presumably to help in the growth of new oocytes, an account of which I propose to give later ; all the same the number of basophils is very much greater than during the prespawning months of May-July. The acidophil number is also considerably reduced. The eggbound catfish can also be made to throw out viable eggs during the post-spawning period but a large dose has to be administered ; they require one homoplastic pituitary gland even though

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the latter shows a large number of basophils. This is because the animals have passed out of the breeding season. The eggs usually undergo lysis and are absorbed. In *Astyanax* (Rasquin and E. H. Atz 1952) the ripe eggs are resorbed by the phagocytic activity of the infiltrating connective tissue and the follicular cells. There is an indication that this also happens in the elasmobranchs. But with aquarium fish according to Dr. D. B. Carlisle (*in litt.*) unless the eggs are voided, the breeders die and in order to prevent their mortality, pituitary or chorionic gonadotrophin is injected into them so that the eggs may be thrown out. He reports that even conger has been saved by this method (see Dodd, in discussion, 1955, p. 185).

It has been found (Ramaswami and Sundararaj 1957a) that the same set of catfish (*Heteropneustes*) can be repeatedly induced to yield viable eggs at an interval of a month or more. A set of catfish yielded ripe eggs after receiving a homoplastic pituitary gland dose in June, i.e., a month before the onset of the monsoon season. In July they were again induced to yield viable eggs and it is interesting to note that during these months, the pituitary gland of these fish show the smallest number of basophils (Sundararaj 1959). In the following September, they were again made to give ripe eggs. It is clear that fish do not ripen and throw away all the eggs on receiving a pituitary injection but retain a large number ; generally in the catfish the eggs that are nearer to the urogenital opening are the ones that ripen and are expelled. Moreover, life in aquaria does not seem to affect the reproductive capacities of catfish, provided they are not crowded and are fed regularly ; they can be induced to yield ripe eggs holding them in aquaria over long periods unlike frogs where spawning is only possible if they are brought fresh from the ponds. Also repeated spawning as described above for the catfish is not possible in the case of frogs.

The relative potency of the male and female catfish pituitary glands in inducing ovulation has also been tested. In *Clarias* the male and female pituitary glands are equally potent ; in *Heteropneustes* bioassay discloses that the pituitary gland of the sexually active male is less potent than that of the female and this is also the case in *Cyprinus* (Ball, R.C. and Bacon 1954). Generally in frogs, the female gland is more potent than that of the male.

It is interesting to note that while it is possible to spawn gravid female fish with homoplastic pituitary glands or with glands from genera of the same order, they prove refractory to fish pituitaries from other orders. We have not succeeded in spawning catfish with the pituitary glands of *Ophicephalus*. This species difference in hypophysial hormones has been brought out clearly by Gorbman (1941) and he said that there existed a relative species specificity. It is always possible to spawn fish with frog pituitaries while the reciprocal implantation is not successful. However, Suzuki (1957) noted that only a small per centage of cyprinid fish spawned after a long time receiving frog pituitary glands but they reacted in a shorter time to loach (*Misgurnus*) pituitary glands. According to Pickford (1957) the spawning of frog using fish pituitary gland is a feat accomplished only partially by E. H. Atz and Pickford (1954), by Wills *et al.* (1933) and Stroganov and Alpatov (1951) ; the second set of workers did not use a sufficient number of animals and the latter set used male test animals. Using the skipper-frog as test animal, it has been possible to get viable eggs by injecting into them five gravid pituitary glands of *Heteropneustes ;* we have found that the skipper-frog pituitary

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glands spawn gravid *Heteropneustes* and *Clarias,* only the latter should receive two successive doses of the pituitary glands.

In studying this species specificity referred to above, immunological behaviour has become an excellent tool. It is noticed that fish growth hormone (Geschwind 1958) is unresponsive in rat, ox growth hormone is responsive in fish and a few mammals but unresponsive in monkey, man and guineapig and that of monkey or man is unresponsive in guineapig. Obviously guineapig has progressed in such a way that its responsiveness has become very limited. With regard to FSH and LH, the difficulty is in preparing pure samples without any contamination. Van Dyke *et al.* (1950) using purified preparations of pig and sheep FSH have shown that the rabbit antisera was found to be species specific to pig and sheep antigens.

Spawning of frogs

The three commonly occurring frogs, viz., the skipper-frog (*R. cyanophlyctis* Schn.), the green-frog (*R. hexadactyla* Lesson) and the bull-frog (*R. tigrina* Daud.) have been used in our experiments. We have also used for comparison the microhylid genera *Uperodon, Kaloula, Ramanella* and *Microhyla,* the polypedtid *Rhacophorus* and the bufonid *Bufo melanostictus.*

Of these, the bull-frog exhibits hibernation during winter and aestivation during summer. It usually emerges adorned in nuptial colours at the outbreak of the monsoon. By about the end of November the ovaries regress and the animals enter into winter sleep. The green-frog exhibits two breeding periods: the main one during the monsoon season and a subsidiary one during winter. The skipper-frog is the smallest of the three and has its main breeding season during the monsoon. Gravid females are available before and after the season.

During the breeding season, freshly captured gravid frogs yield ripe eggs with homoplastic pituitary parenteral injections. It has been found, however, that in the case of bigger species (*tigrina* and *hexadactyla*), a small dose of pituitary glands to prime up the ovary followed after a lapse of 12 hr with a small dose of pituitary glands plus chorionic gonadotrophin (Antuitrin S: Parke Davis ; Physex: Dumex) brings out the viable eggs more effectively (unpublished).

Spawning catfish and frogs with mammalian hormones

We have used the mammalian hormones put on the market to test the spawning reactions of the catfish and frogs (Ramaswami and Lakshman 1958a, 1958b, 1959a, 1959b). I have provided a table (Table 1) giving an account of the action of mammalian hormones on the catfish and the skipper-frog. It must always be remembered that a physiological activity like spawning in all animals is the consummate effect of the working of a number of hormones but if in our descriptions we are laying emphasis on one of them at a time, it is because we cannot assay for all of them together. Certain interesting facts emerge from our study.

In our experiments, the follicle-stimulating hormone (FSH) supplied by Armour Laboratories has been used ; this is not pure and contains about 5 per cent of LH as impurity. This became apparent as the gravid catfish (*Heteropneustes*) spawned after receiving 5 mg. dose of it. It was also found that the catfish do not spawn for doses less than

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TABLE 1

Effect of Mammalian Hormones on Catfish and Skipper-frog
(Subminimal dose : 1/16 pituitary gland for *Heteropneustes* (catfish); 1-2 pituitary glands for *Rana cyanophlyctics* (skipper-frog).

Hormone	Catfish		Skipper-frog	
	Hormone only	Hormone plus threshold dose of homoplastic pituitary gland	Hormone only	Hormone plus threshold dose of homoplastic pituitary gland
1. Pituitary follicle-stimulating hormone (Armour) ...	5 mg. +	...	5 mg. −	5 mg. +
2. Pituitary luteinizing hormone (Armour)	5 mg. +	...	5 mg. −	5 mg. +
3. Chorionic gonadotrophin (Physex : Dumex)	250 i.u. +	...	50 i.u. −	50 i.u. +
—do.— (Antuitrin S : Park Davis) ...	100 i.u. +	...	50 i.u. −	25 i.u. +
4. Pregnant mare serum (Serum gonadotrophin = Antex : Dumex)	300 i.u. −	75 i.u. −	30 i.u. −	30 i.u. +
5. Lactogenic hormone (Panlitar : Armour)	1·25 mg. −	1·25 mg. +	2·5 mg. −	2·5 mg. +
6. Estrogen (Estradiol-dipropionate = Ovocyclin P : Ciba) ...	2·5 mg. −	2·5 mg. +*	2·5 mg. −	2·5 mg. +*
7. Androgen (Methyltestosterone : Boots; Perandren : Ciba) ...	5 mg. −	1·25 mg. +	2 mg. +	...
8. 19-nor-testosterone (Organics Inc.)	5 mg. −	5 mg. +*	5 mg. −	2·5 mg. +
9. Adrenocorticotrophic hormone (Andrenomone : Armour; Corticotrophin : Dumex) ...	10 USP −	20 USP −	5 i.u. −	5 i.u. +
10. Progesterone (Ethisterone : Boots; Proluton : Schering) ...	5-10 mg. ±	2·5 mg. +	1 mg. +	...
11. Cortisone acetate (Corlin : Glaxo)	25 mg. −	6·25 mg. +	25 mg. −	6·25 mg. +
12. Prednisone acetate (Deltacorlin : Glaxo) ...	5 mg. −	2·5 mg. +	5 mg. −	5 mg. +
13. Desoxycorticosterone acetate (Primocort : Schering) ...	5 mg. +	...	1·25 mg. +	...
14. 17-hydroxycorticosterone (Hydrocortisone : Dumex) ...	6·25 mg. +	...	12·5 mg. +	...
15. Corticosterone (Merck Sharp & Dohme)	10 mg. +	...	10 mg. +	...
16. 11-dehydrocorticosterone acetate (Merck Sharp & Dohme)	10 mg. +	...	10 mg. +	...
17. 17 α-hydroxy-11-deoxycorticosterone (Ciba)	5 mg. +	...	10 mg. +	...
18. Growth Hormone (Somar : Armour)	2·5 mg. −	2·5 mg. +	5 mg. −	1·25 mg. +
19. Thyroid-stimulating hormone (Armour)	2·5 mg. +	...	1·25 mg. −	1·25 mg. +
20. Sodium L - tri - iodothyronine (Glaxo)	0·25 mg. −	0·25 mg. +	0·25 mg. −	0·25 mg. +
21. Thyroxine (Eltroxine : Glaxo)	0·5 mg. −	0·1 mg. +	0·1 mg. −	0·1 mg. +
22. Insulin (Boots)	40 units −	40 units +	40 units −	40 units +
23. Oxytocin (Pitocin : Parke Davis)	5 units −	5 units −	5 units −	5 units −

* Few ripe eggs; +, viable eggs; −, no eggs; ±, indifferent result.

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5 mg. Obviously the amount of LH present in a 5 mg. dose of FSH is sufficient to cause ovulation in the catfish and the question of synergic action between the two gonadotrophins is discussed elsewhere. It is interesting to note that Palmer *et al.* (1954) described that horse anterior pituitary gonadotrophins freed from ACTH failed to have any effect on secondary sex characteristics nor did they hasten maturation of eggs considerably in adult blueblack salmon (*Oncorhynchus*).

Thyroid-stimulating hormone (Armour) also contains sufficient LH to bring about spawning in *Heteropneustes*. It would be interesting to know the effect of pure TSH on the physiology of the catfish.

The function of the lactogenic hormone (Prolactin: Armour) in the lower vertebrates is a vexed question. The hormone brings about spawning in both catfish and the skipper-frog when it is used along with the respective subminimal homoplastic pituitary gland dose. In the mammal, it is effective as luteotrophic, mammotrophic and lactogenic hormone, but the same end points are not perceptible in the lower vertebrates. The ox and sheep lactogenic hormone caused a brooding behaviour in the jewel fish *Hemichromis* which had previously spawned (Noble *et al.* 1938), melanogenesis in hypophysectomised killifish *Fundulus* (Pickford and Kosto 1957) and the expression of the water-drive factor in the terrestrial hypophysectomised newt *Diemyctylus* (Grant and Grant 1958); the same water-drive test also proved the presence of prolactin-like hormone in the teleosts (Grant and Pickford 1959). It is likely that the function of the hormone is different in the different classes of vertebrates.

It is pointed out (Pickford and Atz 1957) that administration of chorionic gonadotrophin (CG) and pregnant mare serum (PMS) may depress the gonadotrophic activity in the fish pituitary. That the latter hormone does suppress the gonadotrophic secretion from the pituitary gland is well brought out by our experiments on the catfish and the skipper-frog. PMS does not bring about ovulation in the catfish and the skipper-frog as it supposedly corresponds with FSH; but when it is used along with a threshold homoplastic pituitary gland dose, the skipper-frog alone spawns. The catfish receiving a similar combination dose does not spawn. Obviously, while the release of gonadotrophic hormones is not affected in the frog, it is apparently suppressed in the catfish. Hasler, Meyer and Field (1939) were able to bring about spawning in *Salmo* almost at the end of spawning season by injecting PMS. Egami (1954b) showed an increase in the weight of ovary of *Misgurnus* by administering 8 intra-muscular injections of 50 i.u. of PMS (Anteron: Schering) two to three months before spawning season. In view of the above two results, it is not clear why *Heteropneustes* did not react to PMS.

Ovulation cannot be brought about in the catfish and in the local frogs by the administration of cortisone acetate or adrenocorticotrophic hormone (ACTH). When cortisone is injected with the respective threshold pituitary gland dose both animals spawn. With regard to ACTH, the local frogs spawn when it is injected with a homoplastic pituitary gland dose; the catfish, on the other hand, is refractory to a similar combined dose. What is the probable cause of this difference? It has been recorded by Rasquin and Hafter (1951) and Rasquin and E.H. Atz (1952) in *Astyanax* that injection of cortisone and ACTH brings about resorption of some mature oocytes when their follicle cells become hyperplastic and hypertrophied. Such corpora atretica may be the source of ovarian steroid hormone. In order to test for possible steroidogenesis,

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J. N. Ball (1960) has employed the Schultz method and found that while early corpora atretica are negative to the test, older corpora give a strong positive reaction. It is known that cholesterol is present in appreciable amounts in fish eggs and the Schultz technique gives various degrees of reaction and J. N. Ball would consider probably a reaction positive when a large amount of cholesterol accumulates in the corpora and gives a strong reaction.

In the stickleback follicular degeneration is brought about by gonadal steroids and a number of other environmental factors and during this process the pituitary gonadotrophs are adversely affected according to Stanworth (1953). E.H. Atz (1953) described in both sexes of *Astyanax* that saline, ACTH or cortisone caused cyclical de- and re-granulation of the thyrotrophs and of size reduction and its restoration in the gonadotrophs. In the goldfish Chavin (1956) reported no change in the basophils on injecting the fish with ACTH but the acidophils became larger than basophils, stained deep red and showed deep granulation. In the ACTH administered catfish the basophils appear to undergo no appreciable change in size when compared with the untreated control ; there is also no degranulation of the basophils and this is apparent in our bioassays as no ovulation is brought about. In the cortisone injected catfish, a difference in size of basophils could not be made out when compared with the untreated control and a large number showed a partial or complete degranulation. This probably accounts for the spawning of catfish when a combined dose of cortisone plus homoplastic threshold pituitary gland is injected and not in the case of injection of a combined dose of ACTH with the pituitary gland.

That certain adrenocortical hormones help or potentiate some of the pituitary hormones during ovulation in mammals is well established. Cortisone is known to assist LH in bringing about ovulation in mammals. Such a possibility has been described by Chang and Witschi (1957) in the ovulation of frogs also. We have tested this in our frogs. It has been described (Ramaswami and Lakshman 1958b, 1960b) that cortisone or LH does not bring about ovulation in the skipper-frog. If there is a synergism between cortisone and LH (or CG, which mimics the action of LH), ovulation should ensue if these are injected into the skipper-frog. This is exactly what happened and the skipper-frogs receiving these doses spawned profusely. The *in vitro* experiments (unpublished) on skipper-frog ovary showed that cortisone helped in creating a pore in the follicle envelope and the chorionic gonadotrophin or LH was necessary for expressing the ovum out. This, therefore, confirms the assumption of Chang and Witschi that cortisone helps in ovulation. While this is so, it has been found that in Teleostei and Amphibia hydrocortisone (cortisol) is the main adrenal cortical secretion and not cortisone (Chester Jones *et al.* 1958) ; it is very likely that cortisone in one form or another may be playing its part if not as primary at least as an ancillary to the main ovulation hormone.

It must be impressed here that in the skipper-frog FSH or ACTH or LTH or thyroxine when administered along with CG did not cause ovulation (unpublished). On the other hand in the leopard frog (*R. pipiens*) a mixture of mammalian FSH and LH brought about spawning in the intact and hypophysectomised animals and a fairly pure fraction of FSH also caused the frog to ovulate during January-March but the pituitary ablated animals failed to yield ripe eggs (Wright and Hisaw 1946). *Xenopus* spawns with cortisone (Burgers and Zwarenstein 1955) but our frogs and *pipiens* do not react on receiving this steriod.

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The effect of some steriods appears to be different in the catfish and the frog. The catfish are unaffected by androgen and generally by progesterone but the frogs spawn profusely on receiving them. However, in *Misgurnus* Kirshenblat (1952) obtained ripe eggs upon injecting androgen, DOCA and progesterone.

A large body of evidence goes to prove that the effect of androgen on the piscine ovary is one of inhibition as in the mammals ; in the former, oogenesis is stayed and ova start degenerating. This has been noticed in *Heteropneustes* also. DOCA, estradiol, testosterone and progesterone suppressed the developing gonad in *Salmo* (Ashby 1957) and in *Oryzias* the same effect has been described by Egami (1954a, 1954c, 1955) using DOCA and estrogen. It should be noted, however, that DOCA, 17-hydroxycorticosterone, corticosterone, 11-dehydrocorticosterone, 17α-hydroxy-11-deoxycorticosterone brought forth ripe eggs both in the catfish and in the skipper-frog.

Wright (1961) found *in vitro* experiments of frog ovary progesterone to be a potent ovulating agent in concentrations as low as 0.01 mg. of the steroid in 50 ml. of Ringer solution. Other steroids including methyltestosterone were not so effective ; androgen was found to be quite effective in inducing ovulation in the ovarian piece when used along with a homoplastic pituitary gland dose. It is brought out by him that since progesterone occurs naturally in amphibian ovarian tissue, it may be the agent responsible for ovulation, or probably a near derivative of it. Ovarian tissue could convert any steriod into a progesterone like compound. It should, however, be remembered that eggs ovulated *in vitro* cannot be fertilized unless they are made to pass through the oviduct of the frog. The statement of Wright with regard to progesterone as the ovulatory hormone may not apply to the catfish as they are refractory to androgen and give only indifferent results with progesterone.

Injection of androgen into catfish brings out the secondary sex characteristics very effectively. The urogenital papilla of the female elongates and becomes intensely vascular. In the female minnow *Hyborhynchus* testosterone caused the appearance of breeding tubercles on the snout characteristic of the breeding male (Ramaswami and Hasler 1955).

Hormones and growth of Ova in Fish

As the piscine and amphibian pituitaries produce FSH and LH gonadotrophins comparable to mammalian ones, it is reasonable to assume that their action on the ova may not be very different. Follicle-stimulating hormone helps in the growth of the follicles while LH brings about the ovulation of the ripe eggs. A certain amount of synergism exists between the two hormones. However, Witschi (1955) considered that LH was a more important factor than FSH in the fish pituitary and that the pituitary gland stored it ; when necessary it could secrete a small amount of FSH. Kirshenblat (1956) described that LH alone was responsible for the growth and maturation of gonads in fishes. In this connexion, J. N. Ball (1960) discusses that in a number of teleosts (*Cottus, Phoxinus, Rhodeus, Zoarces, Gasterosteus,* trout and *Coregonus*) oocyte formation is a continual process and is enhanced during the post-spawning period. Further according to him "Oocyte formation and vitellogenesis may thus be regarded as broadly alternating phases of ovarian activity ; the former activated by steroid hormones, the latter by pituitary gonadotrophins". That the estrogen helps in early oocyte or auxocyte formation is borne out

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by the formation of oocyte from the germinal epithelium of *Phoxinus* (Bullough 1942) and *Gasterosteus* (Stanworth 1953) on receiving estrone.

Such early stimulation has also been reported by Svardson (1943) in the guppy *Lebistes, Kawamoto* (1950) in *Ctenopharyngodon* and Laskowski (1953) in *Platypoecilus* (*Xiphophorus*). Gerbil'skii (1940) attributes the formation of oocytes during the post-spawning period to the ovarian hormone. Further evidence for the origin and persistence of early ova in fish comes from hypophysectomised fish ; older ova needing FSH for vitellogenesis degenerate and the young ova continue to be unaffected. Generally it is noticed that homologous sex hormones repress the ovaries (Pickford and Atz 1957).

Kazanskii (1951, 1952) found that in obtaining growth and maturation of oocytes (*Gasterosteus*), the acetone dried homoplastic pituitary lacked a factor present in fresh pituitaries. This according to him was responsible for vitellogenesis and it becomes inactive when the pituitary glands are acetone dried. This is presumably none other than the FSH-like hormone of the fish pituitary gland.

Working on the reproductive cycle of *Heteropneustes* Sundararaj (1959) described that the growth of ova was a continual process and that there does not seem to be a break between the various stages. During the post-spawning period (November-January), a large number of auxocytes appear and a few small oocytes are also noticed in the periphery of the ovary at the height of the spawning season. While there is degranulation of a few basophils during spawning season (August-October), greater degranulation takes place during the post-spawning and preparatory periods. Since only a few basophils degranulate during the spawning season it is inferred that a small amount of LH is released to help ovulation. This also explains the occurrence of a large number of eggbound females which fail to ovulate on account of a small release of LH in the spawning period. The greater secretion of gonadotrophin after the spawning season is assumed by Sundararaj to help not only in the formation of new oocytes but also in their growth, viz., vitellogenesis. If estrogen is responsible for early oocyte formation as narrated above, it would mean that in the catfish the elaboration of estrogen in the ovary to help form oocytes and of the gonadotrophins (mostly FSH) of the pituitary to help in vitellogenesis are going on hand in hand. This would naturally raise the question if estrogen does not suppress the release of FSH according to the feed-back theory.

It is noticed that mammalian hormones unconnected with ovulation can also act synergically and bring about ovulation in the catfish and the skipper-frog. Growth hormone, luteotrophic hormone (LTH) and insulin belong to this category and cause ovulation in the catfish and the skipper-frog when injected with respective subminimal pituitary gland dose. However, Burgers and Li (1960) described that beef growth hormone brought about ovulation *in vitro* ovary of *R. pipiens*. They described that the ovarian fragments were shaken to release the eggs. It is not known if ovulation would have taken place if the fragments were not thus mechanically treated. Both Dr. Witschi (*in litt.*) and I have noticed that when pieces of ligatured ovary are put in cortisone (added to Ringer solution), the follicle opens out an ovulation pore as pointed out previously, but for actual ovulation addition of pituitary gonadotrophin is necessary. We do not mechanically disturb the ovarian fragments in the experiments. Further it has been pointed out by Burgers and Li that growth hormone acts directly *in vitro* ovary.

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The only posterior pituitary hormone that we have tested is Oxytocin (Pitocin : Parke Davis) ; this does not bring about ovulation in the catfish or in the skipper-frog even with respective homoplastic pituitary gland dose.

The importance of thyroid activity during reproduction of fish is gaining ground and our experimental results with regard to ovulation vis-a-vis thyroid are yet unpublished.

The work of Kalashnikov and Skadovsky (1940, 1948) indicates that sturgeons maintained under artificial conditions suffer from hypothyroidism and the ova undergo degeneration. The latter was stopped by thyroid hormone injection and normalcy was restored in the ova. Better results are obtained with pituitary injections in fish if these are preceded by thyroid hormone injection. It is also found that some autumn spawning fish (*Coregonus*?) mature eggs with smaller dose of bream pituitary gonadotrophins coupled with thyroxine than when they received the former alone ; the same fish showed hyperthyroid activity during the time of ovulation (Pickford and Atz 1957). Olivereau (1954) also recorded hyperthyroidism in the salmon during spawning. Minnows (*Phoxinus*) maintained in thiourea not only failed to develop external sex characteristics but also the germ cells failed to complete their maturation (Barrington 1954). Barrington and Matty (1954) have also come to the same conclusion with regard to *Phoxinus*. However, Barrington (1954) described the completion of spermatogenesis with artificial light in thyroidectomised *Phoxinus*. It was found in sticklebacks that the hyperthyroid activity during the breeding period was somehow connected with their loss to stand increased salinity (Heuts 1943). Baggerman (1957) has brought out similar observations with regard to the migration of the sticklebacks ; thyroxine induces freshwater preference and this happens during the breeding season when the gonads are ripe and on the other hand, thiourea induces a saltwater preference. The latter preference appears only after the end of the breeding season. It is not clear if hyperthyroidism is responsible for the ripening of the gonads.

So far as I am aware no work has been done to test the spawning reaction of a fish after thyroidectomy. Catfish (*Heteropneustes*) were injected 1 ml each day of a molar solution of thiourea. At the end of five days they were tested for spawning. A homoplastic pituitary gland dose did not make them spawn while the controls receiving the dose reacted and yielded ripe eggs. This experiment is open to the criticism that the drug was used for a short time and one may ask if the result obtained is due to the action of thiourea at all. It is true that thiourea takes a long time to bring about hypothyroidism (Srivastava 1960) and in *Heteropneustes,* while some thyroid follicles showed flattened epithelium, others showed its hypertrophied nature. The animal apparently was incompletely affected but all the same, the end point of throwing ripe eggs was not there. We are examining this aspect in greater detail.

When another set of thiourea treated fish were administered subminimal homoplastic pituitary gland dose plus 0.2 gm. of thyroxine, the test animals did not respond while the controls spawned. Probably the reproductive physiology of the test animals has been considerably upset by the goitrogen or it may be that the dose of thyroxine was not sufficient. These hypothyroidic animals do not survive long in the aquarium to enable us to conduct a series of relevant experiments. The animals that were allowed to survive and overcome the effects of goitrogen succumbed very soon.

Results with methylthiouracil have not been so convincing. *Heteropneustes* were held in aquaria for 12 weeks containing 0.05 per

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cent methylthiouracil and the goitrogen-inducing medium was changed every fourth day. These test animals yielded ripe eggs on receiving a small homoplastic pituitary gland dose. Whether the spawning is due to the ineffectiveness of the goitrogen to remove the effect of thyroid gland on the ovary, it is difficult to say ; probably it is so. Generally thiourea appears to be more effective than methylthiouracil.

During these experiments, one peculiarity of the catfish was prominently brought out. These fish come to the surface of water to take bubbles of air as they are airbreathers. After 3-4 administration of thiourea it was found that this periodical rising lessened and the animals used to rest at the bottom of the aquarium for comparatively longer periods with the opercular movements also slowed down. Obviously the partial hypothyroidism induced by the drug had affected the metabolic functions of the catfish and this only goes to support the large body of evidence that the fish thyroid is closely connected with metabolic regulations in fish.

It is generally known in mammals that FSH is responsible for growth of ova, and LH for their dehiscence or ovulation. It is also known that both hormones work hand in hand. It was intended to find out if in the catfish and the skipper-frog similar hormones are elaborated and if so, whether they work synergically. It may be mentioned in passing that Zahl (1935, 1937) after studying the annual cycle of the pituitary gland in *R. pipiens* and conducting castration and implantation experiments came to the conclusion that the acidophils caused ovulation and that the basophils were helpful in the growth of ovarian follicles. Kerr (1939), Aplington (1942), Copeland (1943), Zuber-Vogeli (1953) and Cordier (1953), amongst others, have pointed out the importance of basophils in the growth and maturation of germ cells. It is interesting to note that Miller and Robbins (1955) noticed in the urodel *Taricha* that the hormone produced in the basophils was connected with the degranulation of the acidophils.

The pituitary glands of the catfish and the skipper-frog have been treated with enzymes like trypsin, pepsin and ptyaline as has been done for mammals (Bates *et al.* 1934 ; McShan and Meyer 1938, 1939 ; Ch'en and Van Dyke 1939, Chow *et al.* 1939, Abramowittz and Hisaw 1939). Otsuka (1957) has been able to separate the two gonadotrophins from salmon and frog pituitaries and has even described their aminoacid composition. Forty per cent ethanol extracts of salmon pituitary gland showed the presence of serine, aspartic acid, glycine, glutamic acid, alanine, tyrosine, valine, leucine or isoleucine, proline, cystine and an undecided one. Similar extracts of frog pituitaries showed the above minus tyrosine and cystine. Moreover, the FSH of salmon pituitary differs from its LH in having serine, glutamic acid and tyrosine. The composition of FSH and LH of frog pituitary gland is not clear from this paper.

In all our experiments, the spawning of the catfish or of the frog has been taken as the end point indicating the action of the hormone. The pituitary gland homogenates of the catfish (Ramaswami and Sundararaj 1958) and of the skipper-frog (Ramaswami and Lakshman 1960a) after digesting with trypsin or pepsin did not cause the respective test animals to spawn. The homogenates of the pituitary glands of the above two animals after digestion with ptyaline (from saliva) brought forth profuse spawning in respective test animals when injected. In the first set of experiments, the luteinizing factor was inactivated or destroyed and in

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the latter set, it is the FSH factor that is put out of action. Thus in these animals LH factor can alone bring about spawning and FSH does not appear to be necessary. Moreover, when the LH containing (ptyalin digested) and the FSH containing homogenates (pepsin or trypsin digested) were used together (1 FSH : 4 LH), the spawning was not more profuse in the skipper-frog than when LH alone was used. This leads us to infer that a synergic action is probably not present in the frog and not having tested for FSH, one cannot be very definite about this conclusion. Burgers and Li (1960) have also pointed out the absence of a synergic action between sheep FSH and LH *in vitro* ovary of *R. pipiens*. This can be verified further if purified piscine gonadotrophic hormones are obtained and tested for FSH-like and LH-like reactions.

While it has been possible to establish the presence of LH, that of FSH has not been possible for want of a suitable bioassay method in the fish or frog. Pickford (1958) noticed that hypophysectomised killifish was extremely sensitive to LH and as uncontaminated FSH could not be got, it was not possible to study the effect of FSH. Pickford also records that hypophysectomised male killifish with regressed testes brought forth flow of sperm on receiving growth hormone contaminated with LH and TSH.

The effect of mammalian hormones on pituitary ablated skipper-frogs has been studied. Technical difficulties have prevented hypophysectomy in the catfish. In the skipper-frog (Ramaswami and Lakshman 1960b) it has been found that all the exogenous hormones connected with reproduction mediate through the pituitary gland in reaching the end point, viz., oviposition. It has been brought out (Wright and McIntyre 1950) that when the pituitary gland is meddled with, flow of hormones takes place and their titre in the blood increases. All the same, immediate oviposition by operated individuals does not take place in the skipper-frog as reported by Giusti and Houssay (1922, 1924) for *Bufo arenarum*. Till all the hormones in the blood wears out, injection of an ovulating agent causes the frog to oviposit. Sufficiently long time should be allowed after hypophysectomy for the hormones to disappear from the blood. For example, ten days after hypophysectomy, 5 mg. of DOCA brought about spawning in the operated skipper-frog ; there was no spawning with the same dosage 16 days after pituitary ablation. A combination dose of cortisone and chorionic gonadotrophin (Antuitrin S : Parke Davis) did not bring about ovulation 4 days after hypophysectomy in the skipper-frogs and even a second dose 2 days later did not cause them to spawn. According to Wright (1945) and Wright and Hisaw (1946), a sample containing FSH and LH of sheep pituitary gland brought about ovulation in hypophysectomised and in tact animal and also *in vitro* ovarian pieces of *Rana pipiens*. However, fairly pure sample of sheep FSH brought about ovulation during January-March in *pipiens* but was ineffective on pituitary ablated and *in vitro* ovary of the same species.

The Cytology and Histochemistry of the Normal Pituitary Gland of Catfish and Skipper-Frog

The topographical disposition of the parts in the fish pituitary gland is not the same as in the frog or in a mammal. Briefly, the fish pituitary exhibits a highly branching nervous lobe and an anterior portion considered to be the homologue of the pars tuberalis of the mammalian adenohypophysis and a posterior portion called pars intermedia. The middle portion known as the transition lobe or ubergangsteil, corres-

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ponding to the pars anterior or glandular part is the secretory region where the glandular basophils and acidophils secrete the hormones. Pickford (1957) has therefore, used the non-commital terms pro-, meso and meta-adenohypophysis for these three regions.

The basophils are known to elaborate the three pituitary hormones FSH, LH and TSH (or more correctly, their precursor substance) which are glyco- or muco-proteins. Ordinarily the basophils of mammalian pituitary glands can be stained blue by Mallory's triple stain (or by Crossmon's modification), magenta by PAS, or purple and red with PAS-methyl blue-orange G (Wilson and Ezrin 1954, Rennels 1957, Hildebrand *et al.* 1957) and the acidophils in these preparations take a fuchsinophilic (Mallory) or orangeophilic tint. It is now known that certain glycoprotein solvents can be used and the pituitary gland may thus be made selectively to lose its glycoprotein content and after suitable staining one could ascertain the type of cell that is witholding the undissolved hormone. Barrnett *et al.* (1956 have used 2.5 per cent trichloracetic acid (TCA) to dissolve FSH and TSH leaving behind most of the LH in the rat pituitary gland ; similarly they have used half saturated ammonium sulphate solution (½SAS) and 20.5 per cent sodium sulphate solution where only a small quantity of FSH glycoprotein is soluble and the other glycoproteins could be precipitated. In 50 per cent pyridine all the glycoproteins are extracted. The same method has been followed for the catfish and the skipper-frog to test if the LH could be retained in the basophils secreting it and those cells stained differentially as has been done for the normal pituitary gland of the rat by Hildebrand *et al.* (1957). In doing this, it is assumed that the lower vertebrate pituitary gland gonadotrophic secretions are similar to those of mammals.

For bioassays, it has been found possible to use the pituitary glands immersed in the TCA fluid and also the latter fluid (Ramaswami and Lakshman 1960c). With regard to ½SAS and 50 per cent pyridine, only the immersed pituitary glands were used for bioassay as the fluids were lethal to the animals.

A table is provided setting forth the results of these experiments (Table 2).

In the catfish, the pituitary glands immersed for 6 or 12 hr in 1.25 per cent TCA and the acid fluid in which they were immersed brought about spawning. Apparently between 12-24 hr, the glycoproteins are extracted and denatured. In the skipper-frog, the pituitary glands retain the glycoproteins for at least 24 hours in 1.25 per cent TCA and can thus bring about spawning ; the extracting fluid is inactive as it does not extract any hormone or if it does, it is denatured immediately.

Cytology and Histochemistry of the TCA-treated pituitary gland of catfish and of skipper-frog

In the normal rat, a tinctorial differentiation of the three cell types in the pars anterior of the adenohypophysis has been brought out lately by Rennels (1957) and Hildebrand *et al.* (1957) and in *Xenopus* by Saxen *et al.* (1957). I am not going into the details of this subject. The former sets of authors have shown PAS positive red (thyrotrophs and LH gonadotrophs) and PAS positive purple-blue hasophils (FSH gonadotrophs) and the acidophils being orangeophilic. In *Xenopus* both thyrotrophs and acidophils come out red with the same PAS-methylblue-orange G technique and the basophils are blue. Ezrin *et al.* (1958) pointed out that

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TABLE 2

Action of Trichloracetic acid, Ammonium sulfate and Pyridine on the Pituitary gland of Catfish and Skipper-frog

	Heteropneustes (Catfish)				*Rana cyanophlyctis* (Skipper-frog)			
	1·25% TCA		2·5% TCA		1·25% TCA		2·5% TCA	
Period of immersion	Immersed Gland only	TCA Fluid only	Immersed Gland only	TCA Fluid only	Immersed Gland only	TCA Fluid only	Immersed Gland only	TCA Fluid only
6 hr.	+	+	−	−	+	−	−*	−
12 hr.	+	+	−	−	+	−	−	−
24 hr.	−	−	−	−	+	−	−*	−
36 hr.	...	...	...	...	...	...	−	...

* One specimen gave a few eggs.

Half-saturated Ammonium sulfate

Period of Immersion	Catfish Immersed gland only	Skipper-frog Immersed gland only
24 hr.	+	+

50 per cent Pyridine

Period of Immersion	Catfish Immersed gland only	Skipper-frog Immersed gland only
24 hr.	−	−

+, viable eggs; −, no eggs.

in the human adenohypophysis, it was possible to differentiate PAS red and PAS blue-purple basophils using the PAS-methylblue-orange G technique. A further differentiation of the PAS blue-purple was possible by adopting the technique of Ritter and Oleson (1950) into heavily granulated delta cells and lightly granulated gamma cells. The beta basophils stained PAS red and the alpha cells take orange G and are the acidophils. While a differentiation into PAS red, PAS purple-blue and orangeophilic cells is possible in untreated pituitaries of the skipper-frog, the TCA treated ones do not show such a colour differentiation.

It has not been possible to differentiate tinctorially the different types of basophils using PAS-methylblue-orange G technique in the catfish untreated pituitary gland. In the meso-adenohypophysis (transition lobe) very large and small intensely staining PAS positive basophils and orange G acidophils are met with. The PAS positive basophils cannot be further differentiated into PAS purple-blue cells or PAS red cells as has been done in the rat (Hildebrand *et al.* 1957). However, a few of the PAS positive large and small cells show a red tinge also. Some of the PAS positive basophils could not be selectively stained with AF technique for

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thyrotrophs as they are not amenable to this stain. In some bony fish it has been possible to stain the thyrotrophs with this method (Barrington and Matty 1955 ; Matty and Matty (1959) while in others like *Astyanax* (E. H. Atz 1953), *Lebistes* (Sokol 1955) and *Mugil* (Stahl *et al.* 1960) it is not successful. It may not be out of place to mention here that Landing (1957) working on the pituitary glands of normal children showed that all the basophils were AF positive (with or without oxidation) using formol as a fixative : with sublimate-formol as the fixative, a week AF reaction is obtained in all basophils without oxidation.

According to Romeis (1940), some of the basophils of the human pituitary gland could be selectively stained with resorcin-fuchsin of the Kresazan technique and these cells represent the beta cells or thyrotrophs. In *Heteropnustes* also some of the basophils appear resorcin-fuchsin positive and therefore, they may represent the thyrotrophs ; at present a differentiation of the basophils into gonadotrophs and thyrotrophs has only been possible in the catfish and we are studying this aspect in detail.

I have examined the pituitary gland of *Labeo rohita* collected in May at Jaipur ; the fish were not fully gravid. Crossmon's Mallory discloses in the pituitary gland blue basophils and red acidophils ; some of the basophils are intensely blue. A set of basophils, angular in outline, exhibits a purple colour and very likely they are different from the blue basophils. In a Kresazan preparation of the pituitary gland of *rohu*, these purple basophils appear to take the resorcin-fuchsin stain and appear either brown or purple. These are probably the thyrotrophs.

Trichloracetic acid treated pituitary glands of catfish (1.25 or 2.5 per cent ; 6, 12 or 24 hr) show light blue basophils when stained with Crossmon's stain or Cleveland-Wolfe and light magenta colured basophils in PAS-methylblue-orange G. The basophils of the TCA-treated pituitaries of catfish (1.25 per cent : 6 or 12 hr) do not show a greater intensity than the basophils of pituitaries which do not bring about a ripening of the eggs. These cells which show the PAS positive material are the LH cells as TCA dissolves the FSH and TSH glycoproteins from the other basophils.

The TCA extraction experiments on the skipper-frogs were conducted during the month of February. The normal untreated pituitary glands of the skipper-frog show the following cell types :

Stain	Basophils			Acidophils
PAS-methyl-blue-orange G.	PAS brick-red : columnar	PAS Brick-red or brownish large and angular	PAS purple-blue : columnar	PAS purple-blue : angular	Orangeophilic
Cleveland-Wolfe	Blue	Blue or purplish	Blue	Blue	Erythrosinophilic
Mallory	Blue	Blue	Blue	Blue	Fuchsinophilic

We have not yet tried the Romeis Kresazan technique on the skipper-frog to find out whether the large angular brick-red or brownish basophils answer to thyrotrophs by being resorcin-fuchsin positive. We have not been successful with AF technique in the frog also.

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In the skipper-frog pituitary gland treated with TCA, the PAS positive brick-red cells and the purple-blue cells referred to above do not show this tinctorial differentiation but they appear as PAS positive columnar and angular cells. However, a number of these columnar cells which are PAS positive appear vacuolated ; this may be due to the dissolution of FSH and TSH from those basophils. Certain columnar cells do show the presence of glycoprotein granules and these were presumably the PAS positive red cells. If this argument is correct, then we may be right in assuming that PAS brick-red or brownish basophils are LH and TSH secreting cells while PAS purple-blue basophils are responsible for the elaboration of FSH.

Pituitary cytology of Hormone injected skipper-frog

Gravid female skipper-frogs have been treated with estrogen, 19-nortestosterone (testosterone brings about spawning) and thyroxine. A few gravid females were also ovariectomised. The effect of these treatments on the pituitary gland has been studied. I am taking the estrogen and thyroxine experiments together. In this connexion it has been described by Purves and Griesbach (1955) in the mammal that estrogen suppresses the gonadotrophs and the thyrotrophs are unaffected while it is the opposite in the case of thyroxine treated ones. In the pituitaries of the skipper-frog studied by us, the estrogen treated ones showed a large number of PAS positive cells, a large number of unstained columnar cells and a few acidophils which were poorly stained with orange G. If the PAS positive cells referred to above had given an indication tinctorially and morphologically that they belonged to the TSH secreting type, we could have referred the unstained cells to other hormone secreting basophils. Morphologically the PAS positive cells look very much like the unstained ones and as no clue as to their identity was available, we do not propose to classify them at present. This has happened with our other experiments in this connection also and we are examining this in greater detail.

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SECTION OF ANTHROPOLOGY AND ARCHÆOLOGY

President :—Dr. Surajit Sinha.

PRESIDENTIAL ADDRESS

STATE FORMATION AND RAJPUT MYTH IN TRIBAL CENTRAL INDIA

Mr. Chairman and Friends :

Please allow me to take this opportunity to express my gratefulness for the invitation to take the Chair in Anthropology and Archaeology in the current session, before I present my paper.

Introduction

My first field experience in Anthropology was among the Ho of Kolhan (Singbhum), who have been described by various ethnographers as a fairly primitive representative of the Kolarian or the Mundari group of tribes (Dalton, 1872). Following the leads given in the later reports on the Ho by Majumdar (Majumdar, 1950), I was quite intrigued by finding in the same group a class of people, the Manki or chief of an area (Pir) comprising more than a dozen of villages, who lived in a commodious house, maintained a number of servants, strictly avoided any manual labour, indulged in the luxury of keeping mistresses, and so on. Although this Manki shared the same clan as that of the average tribesmen in the surrounding villages, he and his close agnates distinctly stood apart as a class. In course of time I came to know that the chief of Bharbharia Pir was a sort of fief holder under the Raja of Mayurbhanj before the British Rule. Later on, while studying the Bhumij and the Munda of Chotanagpur I came across similar and even more highly aristocratic strata and attendant aristocratic moods among these so-called tribal people. A little probing into these societies and a few others indicated fairly long-standing association of these tribal groups with feudalistic states. Thus the Gond had their famous kingdom of Garha-Mandla, Deogarh and Chanda (Chatterton, 1916), the Bhuiya are linked with the State of Keonjhar (Cobden-Ramsay, 1910), the Munda with Chota Nagpur Raj (Dalton, 1872), the Bhumij with Barabhum (Dalton, 1872 ; Risley, 1891 ; Sinha, 1957) and so on. As a matter of fact, it is hard to find any settled agriculturist tribe of importance in the entire tribal belt of Central India, with the possible exception of the Santal, which has not been substantially affected by long-standing connection with feudalistic state organisations.

The most important consequence of this development is that the main body of the tribe has often been stratified into social classes mainly in terms of differential land-holding and of the territorial extent of political dominance. This fact of stratification again, has set the various segments

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of the once relatively egalitarian tribes in a perpetual craze for social upgrading. The most striking feature in these processes is that all over this vast territory of Central India, the peak point of identification of social movements among the tribes is the Rajput of North-West India who are regarded as the true representatives of the traditional Kshatriya class. As a result of these social movements which have gone on for centuries there are today Rajputs and pseudo-Rajputs of varying order of prestige throughout this tribal tract. The highest being the traditional princely clans of Rajasthan belonging to the familiar Solar and Lunar branches and on the lowest rung are the recent entrants into the chain from the tribal upper class. In other words, state formation in the tribal belt of Central India is very largely a story of *Rajputisation* of the tribes.

Most of the early ethnographers of tribal India like Dalton, Risley, Russel and Hira Lal, and Roy, in spite of their considerable knowledge of these historic processes among the groups they studied—probably in their primary urge to record the most primitive core before they were changed too far—paid somewhat inadequate attention to the complex developments which connected these tribes with Hindu civilization. This essay is an attempt to follow up the developmental processes as well as the consequences of the formation of states in tribal Central India. We shall discuss such questions as conquest vis-a-vis evolutionary theories of state formation, and investigate the techno-economic, social, military and symbolic conditions favouring the growth of State. Our primary concern, however, will be with the consequences. Here we are interested in following up how the egalitarian primitive clan-based tribal organisation has adjusted to the centralized, hierarchic, territorially-oriented political developments, the nature of social class formation, interaction between the primitive ritual symbols of the tribe and the advanced symbols sponsored by the States and the effect of such historic processes on the minds of these people in relation to the current canvas of rapid economic and political changes.

Our task is made extremely difficult due to lack of reliable historical material in Pre-British times when these kingdoms or chieftaincies actually came into being. The Moslem records on these areas are also much too inadequate and the spurious long genealogies of the aspirant pseudo-Rajput tribal chieftains are often quite misleading. The archaeological ruins of Jaina, Buddhist and Hindu periods, belonging approximately to the period between the eighth and twelfth centuries A.D., which are sporadically scattered over this territory, seem to date considerably prior to the formation of these tribal states. Under the circumstances our enquiries will have to be based mainly on the structural insight that we gain by studying a number of contemporary or recently ruined States in the area.

We may, therefore, begin with a fairly detailed analytical description of the estate of Barabhum in the former Manbhum district of Bihar[1] in relation to the Bhumij tribe, where the writer had done field work, off and on, for about four years between 1950 and 1960.[2] This detailed description will be followed by brief comparative notes on some of the other feudalistic States and Zemindaries in Chhattisgarh, Chotanagpur and Gondwana.

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[1] Since November 1, 1956, the bulk of Manbhum has constituted the new district of Purulia in West Bengal.

[2] It is a pleasure to put on record here the assistance received from Biman Kumar Dasgupta and Hemendra Nath Banerjee of Anthropological Survey of India, in undertaking an over-all Survey of Barabhum Pargannah during 1958 to 1959.

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II

Barabhum, a Bhumij Kingdom

A kingdom from a tribal base

The Pargannah or estate of Barabhum in South Manbhum covers an area of 635 square miles and 244,733 people. It has 596 revenue villages or *mauzas* of which 20 are no longer inhabited. Of the 64 castes living in this Pargannah the numerically dominant groups are : the Kurmi (71,892—30%), the Santal (40,236—16%), and the Bhumij (37,947—15%). Of these three the Bhumij are locally regarded as the earliest settlers, who had cleared the virgin forests and set up villages as *Khuntkatti* tenure holders. Also, they nearly monopolised the offices of the village headman, *Ghatwal,* and village priests, *Laya.*

When the British first came into contact with Barabhum around 1770, the Raja of Barabhum was apparently an independent king or chief owing allegiance to no superior authority (Higginson, 1771). He was already claiming to be a Rajput Kshatriya and spoke an Aryan language, i.e., Bengali. There are no records of Muslim or Maratha incursions into Barabhum. The earliest semihistorical reference to the Bhumij state of Barabhum is to be found in the Brahmanda section of Bhabishya Purana compiled in the fifteenth or the sixteenth century A.D., where it is stated :

"Barabhumi is in one direction contiguous to Tungabhumi and in others to Shekha mountain ; and it comprises Barabhumi, Samantabhumi and Manbhumi. This country is overspread with impenetrable forest of *shwal* and other trees . . . In the same district are numerous mountains, containing mines of copper, iron and tin. The men are mostly Rajputs, robbers by profession, irreligious and savage. They eat snakes and all sorts of fish, drink spiritous liquors and live principally by plunder or the chase. As to the women, they are, in garb, manners and appearance, more like Rakshashis than human beings. The only aspects of veneration in these countries are rude village divinities" (Coupland, 1911).

The prevailing myth about the origin of Barabhum Raj runs roughly as follows :

A prince from Rajputana was going on pilgrimage to Puri accompanied by his pregnant wife. On the way, near Rupsang village in the area which later on became known as Barabhum, the queen gave birth to a pair of twins, without the knowledge of the king and left them by the side of a forest. A pig took pity on these babies and reared them along with her own litter with her milk. The Bhumijes belonging to Gulgu clan rescued these godly babies by killing the pig. The twins became known as Svet Baraha (White Boar) and Nath Varaha (Nath, the Boar). As the boys grew up the Bhumijes watched with admiration and amazement the remarkable mental and physical qualities of the boys, and were convinced of their Kshatriya parentage. The Bhumijes then took the boys to the court of Raja Vikramjit of Patkum, who used to rule over this tract in those days. It is said that, impressed by the princely courage of the brothers, Vikramjit honoured Nath Varaha with a portion of his own kingdom. This new kingdom, having a circumference of 16 *Yojanas,* came to be known as Barabhum. A slightly different version of the same legend is given by Dalton in his *Descriptive Ethnology of Bengal* (1960 : 174).

It is hard to decide as to what truth can be salvaged from this myth. The legend of a Rajput prince of North India going with his pregnant

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wife on pilgrimage to Puri is associated with the miraculous origin myth of a number of other states in Central India and Orissa. It is not difficult to adapt such a prevailing myth to prove Rajput ancestry for a powerful tribal chief. This particular myth, however, seems to indicate that Patkum was established earlier than Barabhum and Barabhum was perhaps, in the beginning, a feudal frontier chieftaincy under Patkum. The most significant point in this legend, nevertheless, is the tradition that the ancestors of Barabhum Raj were reared by the Bhumij of Gulgu clan, just as the first ancestor of Chota Nagpur Raj is said to have been reared by the Madra Manki, the Munda chief of a Parha (Roy, 1912 : 138). There is also the tradition in Barabhum, that before settling down at Barabazar, the present capital, the Rajas of Barabhum had their forts (*Garh*) at Pabanpur and at Bhuni. It is of interest to note that Pabanpur lies within a mile of Bhula, the ossuary of the Gulgu clan. The Bhumij priests at Bhuni, where the royal goddess of Koteswari is located in a sacred grove, belong to the Gulgu clan. Again, the village of Rupsang where the twin ancestors of Barabhum Raj were discovered, is also a Gulgu clan dominated village. These repeated associations of the royal family with the Gulgu clan lead us to suspect that the Raj family originally belonged to the Gulgu, which is one of the earliest and most numerically dominant of the Bhumij clans in the Pargannah.

The genealogical table of the Raj family runs through the fantastic depth of forty-one generations between the founder, Nath Varaha, and the presnet Raja or Zemindar. The British came to Barabhum during the reign of Vivek Narayan, the thirty-third descendent from Nath Varaha. The date of inception of the kingdom is given by tradition as 23rd Magha in the second Saka era, i.e., around the third century A.D., whereas a normal ascription of twenty-five years to one generation would place the establishment of the kingdom around 900 A.D. The genealogies, however, appear to be fictitious past a few generations previous to Vivek Narayan.

There is one more important feature worth examining. Near the alleged site of the first capital of Barabhum Raj there are extensive ruins of stone architecture and images which had at one time been conjectured by Cunningham to be the ruins of the capital of King Sasanka of Bengal (Coupland, 1911). There are similar associations of the originally tribal Patkum Raj with the extensive Hindu-Jain-Buddhist remains at Dulmi and of Manbazar Raj with similar ruins at Budhpur near Manbazar. The legends connecting the tribal derived kingdoms with these remains of a higher level of civilisation are clearly imaginary. But the existence of these ruins significantly sets the date of origin of these tribal kingdom at a period later than the breakdown of the earlier extensions of Jain-Buddhist-Hindu civilizations in these hilly tracts around the end of the twelfth century A.D. It thus appears that such tribal kingdoms as Barabhum, Patkum and Panchakot (or Panchet) came into being sometime between the thirteenth and the sixteenth centuries A.D., when we find references to them in Bhavisya Purana (*supra* : 5-6). Moreover, we find a reference to Bir Narain, the Zemindar of Panchet in Mogul chronicles—Padi-San-Nama—around 1632 or 1633 (Gokhale, 1918 : 18-19). It appears to be likely that the Bhumij imbibed some of the ideas associated with kingship after coming into contact with the above-mentioned outposts of Brahmanical civilizations.

The territorial organization that prevailed at the initial stage of British contact in Barabhum provided the Bhumij with a near monopoly on all the important positions of power and land-holding in the regional hier-

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archy. This included the holders of the privileged *Kuntkatti* cultivating tenancies, *Tanbedars* or soldiers enjoying the choicest plots for cultivation ; *Ghatwals,* the headmen and tenure holders of single villages ; *Sadiyals,* the chiefs of about twelve villages ; *Taraf Sardars* or *Sardar Ghatwals,* chiefs of a number of *Sadiyals ;* and finally the Raja or the Zemindar himself. All these office holders from the *Ghatwal* to the *Taraf Sardar* exerted considerable autonomy regarding law and order within their own jurisdictions, and seemed to enjoy this privilege hereditarily as a customary right rather than by virtue of a position granted by the King. This arrangement itself suggests that political evolution in Barabhum was not through sudden invasion and conquest of the region by an aggressive militant immigrant group ; the growth of the state appears rather as a constructive coagulation of traditional socio-political units of the Bhumij. On the other hand, from the local tradition of constant warfare among the neighbouring chieftaincies, it appears that local military pressure contributed considerably towards the kind of territorial arrangement that we find in Barabhum, namely, the chief's directly controlled territory being surrounded and guarded on all sides by frontier fief holders (Dent, 1833).

Even in the early days of British contact with Barabhum, we find the Raja to be a patron of Brahmanism (both of the Sakta and Vaishnava varieties) through numerous grants of villages to the Brahmans. The Raja used to be constantly surrounded by members of the upper Hindu castes, such as the Brahmans, Chhatri, Kayastha, etc., as his advisers in religious as well as in secular matters. It seems to be clear that as the Bhumij chiefs gained ascendancy over the territory of Barabhum they became more and more attracted to the standard of life of larger Hinduised states around them. The inevitable consequence was the bringing in of ever-increasing numbers of higher caste Hindus as secular and ritual officials who helped the chiefs to achieve their desired goal to be regarded as of respectable breed by the civilized Rajput (!) chiefs around them. At what point the Raj family finally succeeded in getting out of this original Bhumij affiliation cannot be ascertained. However, the processes seem to be analogous to the ones described by Roy in connection with the Munda of Ranchi (Roy, 1912 : 134-149).

Apart from receiving the ritual service of respectable Brahmans, the two other crucial features that led to the severance of the tribal affiliations of the Royal Lineage are : (1) creation of a flattering and miraculous myth of origin, and (2) giving up connections with the clan ossuary. In the case of Barabhum Raj, the link with the clan ossuary at Bhula was given up so many generations ago that it is now practically forgotten by the other clan brethren. In the case of the smaller chieftaincy of Baghmundi, the process of Rajputisation has not moved so far ; their Bhumij identity is still recognised by the tribal Bhumij who would point out the line in the clan ossuary where the chief's ashes used to be carried even two generations ago.

A brief outline of the tribal tradition

We should say something at this point about the traditional pattern of society and culture among the Bhumij, who are regarded by all competent ethnographers on the Kolarian tribes as a group closely allied to the Munda of Ranchi. As a matter of fact, the two groups freely intermarry in the border of Ranchi and Manbhum districts. In Manbhum, however, nearly all the Bhumijes have forgotten their traditional language and now speak Bengali, the language of the Hindu immigrants. When Risley studied this tribe in the latter half of the nineteenth century, the

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tribe had already moved quite far towards becoming a Hindu caste and had even started employing Brahmans of inferior status in their rites of passage (Risley, 1915 : 75). However, they still maintain a good deal of their original social and cultural pattern. Like the Munda of Ranchi, the Bhumij are grouped into a number of patrilineal exogamous clans or *Gotras,* which are affiliated to the respective ancestral villages where the clan ossuaries are located. The clans tended to be localised around the ossuary villages. In the case of wide dispersal of the members of a clan, new ossuaries may be initiated for facilitating easy burial of the ashes.

Although the Bhumij have incorporated a good deal of immigrant Hindu magico-religious traditions under the influence of "degraded" Brahman priests and Vaishnava preceptors, they still maintain their loyalty to the traditional gods—the deities residing in the sacred grove (*Jaher Budi, Dessauli*), spirits of hills and forests, ancestral spirits, and so on. In regard to festivals also, the tribal rites like *Sarhul, Jantal, Magh Puja, Buru Puja,* etc., are still maintained along with participation in typical Hindu festivals like *Durga Puja, Ratha Jatra* and so on (Sinha, 1953 and 1958).

Clan and territory

Keeping the above background in mind, let us examine the relation between clan and the administrative segments in the state of Barabhum. According to the Settlement Survey of 1908-13 the various *Tarafs* in Barabhum contained the following number of villages :

Taraf	*Number of villages*
Gartali	120
Dubraji	10
Satrakhani	97
Dhadka	79
Panchasardari	80
Tinsoya	35
Kumaripar	110
Sarberia	48
Bangurda	17
Total	596

Of these, Gartali is the central tract south of the river Kumari under the direct control of the Raja. Dubraji, a *Taraf* of only 10 villages is for the maintenance of the eldest son of the Raja. Except for the two *Taraf Sardars* of Kumaripar who claim to be Rajput Chhatris and are recognised as later immigrants in the region, all the other *Taraf Sardars* belong to the Bhumij tribe. Colonel Dalton speaks of these tenures as follows : "Their tenures are the oldest in the country ; older than the rights of their Chief, who there is every reason to suppose descends from one of the same stock originally elected to rule over them....." (Nandjee, 1883 : paragraph 7).

In the two big *Tarafs* Satrakhani and Panchasardari, the *Taraf* area was divided into a number of tracts known as *Sadiyali,* under subordinate chiefs or *Sadiyals.* Under the *Sadiyal* were the *Ghatwals* or village headmen who often belonged to the Bhumij tribe and usually belonged to the same lineage as that of the hereditary village priest or *Laya.* Like the *Taraf Sardar* in relation to the Raja, the *Sadiyals* and the *Ghatwals*

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enjoyed a good deal of autonomy in their respective areas. Moreover, the authority of the *Ghatwals, Sadiyals* and the *Taraf Sardars* was considerably tempered by the existence of territorial councils of elders at the village, *Sadiyali* and *Taraf* levels where people used to meet in an egalitarian atmosphere. Within the village again, large areas of cultivable lands, often of the choicest kind, used to be leased out at nominal rent to *Tanbedars* or *Paiks,* as service tenures. These *Tanbedars,* mostly belonging to the Bhumij tribe, operated as foot soldiers under the guidance of the *Ghatwals, Sadiyals* and *Taraf Sardars* to defend the territories of the Raja and for other military expeditions.

The situation is thus substantially different from that of European feudalism in which the king granted fiefs to his vassals on a contractual basis (Block, 1961 : 145-175). In Barabhum the Raja and his *Taraf Sardars* are bound by irrevocable traditional ties of long standing. The existence of egalitarian councils of elders at the various levels of territorial hierarchy represents another striking contrast to European feudalism. It should be mentioned here that the relations between the level of the chiefs and that of the Raja were not without tensions. There was an effort on the part of the Raja to expand his direct control over his entire Pargannah and similarly the *Taraf Sardars* also pushed their authority hard on the *Sadiyals* under them.

Risley is under the impression that the four major *Tarafs* as well as *Taraf* Gartali represent the original jurisdiction of five Bhumij clans and that the chief of Gartali attained supremacy by belonging to the senior line :

"It seems to me the present distribution of the so-called *Ghatwali* tenures strongly suggests that body of Mundas divided into *Khunts* or stripes.....settled in Barabhum and cleared the country. There were probably as many *Khunts* as there are *Tarafs* and the ancestor of the present Zemindar was the head of the eldest *Khunt*.....In course of time the Zemindar, from the chief of the eldest *Khunt* of the Bhumij became a Hindu and called himself a Raja.....The present organisation of the *Ghatwals* in Barabhum corresponds so exactly to the Mundari village system in Lohardaga that there can hardly be a doubt that it is the same thing under a different name. The village *Sardar* corresponds to the *Manki* of Munda *Parha.* As for the *Sardar Ghatwals* of the larger *Tarafs* it seems to me most likely that they were originally *Mankis* of outlying *Parhas...*" (Risley, 1883 : paragraph 50).

The actual state of distribution of the Bhumij clans is too complicated today (it must have been more or less similar in Risley's time also) to reconstruct the mono-clanic homogeneous tracts defining the limits of *Tarafs* as hypothesised by Risley. The total of 8,395 Bhumij families spread in 437 villages of Pargannah Barabhum are affiliated to 50 clans with 363 ossuaries. Of these, 17 clans cover the bulk of the population. Each of the four major *Tarafs* contain more than one clan ossuary. *Taraf* Panchasardari, for example, contains as many as five important ossuaries belonging to five clans, leaving aside the occurrence of a few relatively unimportant ones. Even if we break down the data to the narrower range of *Sadiyali,* it does not lead us to a picture of mono-clanic homogeneity. If we take up the case of a single *Sadiyali,* namely that of Koira, we find that of the 15 villages falling within the *Sadiyali* only six are dominated by Jaru, the clan of the *Sadiyal,* three by the Koira, and two each by the Badda, Baghra and Gulgu respectively. At the village level, however, there is a distinct persistence of a tradition that normally the headman and the priest should belong to the earliest settled clan whose

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members have the privileged monopoly over *Khuntkatti* cultivating tenancies. There is, therefore, some degree of idealised correspondence between the clan and the village.

Neither the chief of Barabhum nor the people at large conceive of the *Tarafs* as the areas of particular clans. These are, at least now, regarded as land-revenue-*cum*-political jurisdictions without any reference to caste or clan, except in the matter of the caste of the chieftain. A single *Taraf* like Panchasardari contains, besides the Bhumij with their numerous clans and still more numerous ossuaries, many other castes. Nevertheless, there is an awareness in the minds of the Bhumij that particular tracts of land (not defined in terms of *Taraf*) within Barabhum are lived on by the members of a particular clan. In Bhumij marriages it is still customary to address the members of the gathering in terms of clan groups : "Friends of Jugi clan, of the Jaru clan, and of the Ubursandi clan ! We offer you obeisance and with your permission we begin the marriage rituals."

Although the above-mentioned concrete data on the clan-territory relationship do not lend support to Risley's hypothesis, I do not feel inclined to throw overboard his insights based on long acquaintance with the Kolarian tribes. The very fact that all the Bhumij *Taraf Sardars* invariably belong to the most or one of the most important clans in their *Tarafs* indicates that it may not be altogether improbable that originally the *Tarafs* were the territorial jurisdictions of the major clans, and that the present complex picture is a result of extensive population movement in the Pargannah bringing in many castes and many clans in otherwise nearly mono-clanic *Taraf* areas.

The economic base

The political supremacy of the Raja had the necessary support of economy. Settled agriculture with the plough provided the necessary technological base for the inflow of surplus wealth to the Raja and the hierarchy of chiefs. As the *Taraf Sardars,* who controlled nearly three-fourths of his territory, paid only token revenues to the Raja, his main income was from the *khas* or directly controlled *Tarafs* of Gartali and Dubraji. Here again, it is said that formerly no cash rent used to be levied. Every farmer used to give a certain quantity of rice (*shyama chaul*), clarified butter (*shyama ghee*), and a he-goat (*shyama pantha*) to the Raja on the occasion of *Durga Puja* festival. This sacred festival was thus an important resource for the Royal Exchequer. But the main source of his income was the cultivable plots, *man jami,* that he owned in many of the villages in his *Khas Taraf.* Very often these plots were located near an irrigation ditch (*bandh*). Each tenant had to provide one day's labour with the plough, one day's labour with the hoe and two days' labour with sickles for the cultivation of these plots. The Raja had the advantage of a large supply of labourers in *Khas* plots. The various artisan castes like the potter, blacksmith, basketmaker, etc., contributed a quota of their wares to the king in lieu of land grants. In later periods we also find the king sponsoring weekly markets. The Raja had additional income not only from his own *khas* territory but also from the *Tarafs,* as miscellaneous benevolences on the occasion of coronation, marriage, sacred initiation ceremony, etc., in the family.

The social classes

It must have been anticipated by now that the territorial distribution of power and economic interest in the land would guide the major lines of social stratification in Barabhum, as one moved from the level of the

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Raja down to the level of the Bhumij cultivator. We are already familiar with the territorially defined power hierarchy, i.e., with *political classes.* Following are the important *social classes,* in a descending order, defined in terms of ritual status: Rajput Kshatriyas of Namahal[3] order; Inferior Rajputs of Dashmahal order, who are still recognised as derived from the Bhumij; the upper class or Ataisha Bhumij, who do not take chicken or wine and invariably take *Diksha* from a Vaishnava *Guru* and consult a Brahman priest in the rites of passage; the ordinary Bhumij or Nagadi, who, though enjoying ritual services of "degraded" Brahmans, as do the members of the Ataisha class, usually take chicken and wine and practice widow remarriage; and last of all are the socially degraded or "fallen" Nichu Bhumij whose degradation is often due to breach of the rules of clan exogamy or caste endogamy.

The nature of the interrelation between economic, political and ritual-status hierarchies in Barabhum may be presented diagrammatically, as shown on the following page.[4] There is a fair degree of correspondence between the three systems of hierarchies. This is particularly impressive above the territorial level of the village. Within the village level, even the landless labourer and poor cultivator share the same ritual rank as the headman of the village, whereas even a substantial cultivator may be degraded to the Nichu class for a social offence. It may also be mentioned here that besides forming a hierarchy of marriage classes, a member of a higher socio-ritual class will not accept cooked food or drinking water from a member of a lower class. A Namahal Rajput will not accept water even from a Zemindar of Deshmahal class.

It may be pointed out here that within the district of Manbhum itself there is a class of Rajput Kshatriyas still higher than the Namahal level and this class is represented by Panchet and Patkum Raj families. It appears that the relative position of the various orders of so-called Rajput families has been determined mainly by two factors: the priority in their entrance to Kshatriyahood and the sizes of territories politically and economically controlled by them.

This hierarchic arrangement generates an atmosphere of excessive sensitivity about one's rank and a perpetual drive for higher recognition. The means to achieve these ends are:

1. The employment of Brahmans of the right kind. This could only be done by attracting Brahmans from distant lands with the promise of profuse remuneration in terms of land grants.

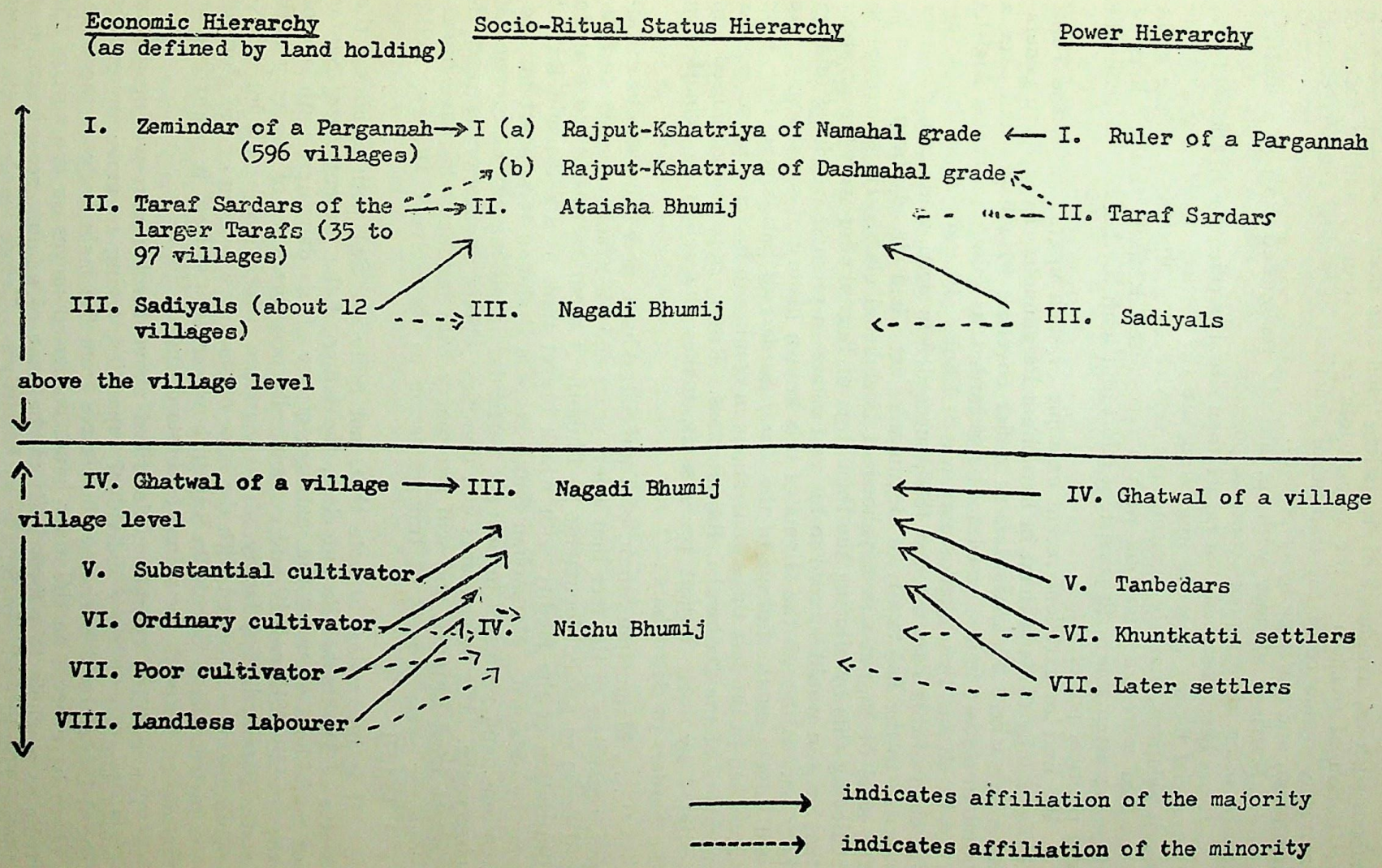
2. Making up, with the help of the Brahmans, a fictitious genealogy establishing mythical connection with the illustrious Rajput clans of North-West India.

3. Ritual display of the right kind. This involves positive actions like observing, under the guidance of priests, typical Brahmanical rites of passage such as, initiation to the sacred thread, observance of Vedic rituals in marriage and funeral rites, maintenance of Hindu idols and temples and associated festivals like *Durga Puja,* etc., and introducing

[3] The Raja of Barabhum with eight other royal or Zemindar families such as Manbazar, Dhalbhum, Ambikanagar, Raspal, Simlapal, etc., form an inter-marrying social class known as the Nine Houses or Namahal. Lower in status there is another group of royal houses belonging to smaller Zemindaris in the same area. Conventionally these comprise ten Zemindar families and are thus known as Dash-mahal. In most of this Dashmahal group of Rajput families such as Baghmundi, Jaipur, Jhalda and Begunkudor, their Bhumij ancestry is still remembered in the locality, though vigorously denied by these aspirant Rajput families.

[4] Information on the village level is based on our data on Madhupur village in Chandil P.S.

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taboos such as, avoidance of degrading food like beef, pork and chicken, restriction of freedom of the women-folk in movement, and in forms of marriage, avoidance of the traditional practices of widow remarriage and leviration, and marriage by elopement.

4. Marriage alliance with an already recognised Rajput Kshatriya family, often in very poor economic position.

It has been observed that rather than ritual purification in the abstract, the crucial factors in social upgrading are the setting up of characteristic social relations, namely, getting the service of a Brahman of the right kind and marriage affiliation with a recognised Rajput family. Both of these are attainable with persistent effort and with the backing of economic and political power.

We find an excellent recent example of such upgrading in the *Taraf Sardar* family of Satrakhani in Barabhum Pargannah. Even three generations ago, these *Taraf Sardars* of a fief covering 97 villages and over a hundred square miles, used to be regarded as Bhumij of the Ataisha class by all and their clan ossuary was at Bhula. Bharat Singh, the powerful chief of this *Taraf* around 1880, succeeded in getting his own daughter married to the Raj family of Begunkudor who had already been raised to the level of Rajput-Kshatriyahood of Dashmahal class. He succeeded in achieving this by alluring the then Raja of Begunkudor with the prospect that his son would succeed to his vast estate—a promise which he fulfilled later on. Although the stigma of this known history of social manoeuvre still lingers on the lineage of the *Taraf Sardars* of Satrakhani, they have succeeded in the last three generations in coming to be regarded as regular members of the Dashmahal Rajput class. Risley, apparently amused and irritated by their Rajput pretensions, makes the following remarks on the *Sardars* of Satrakhani:

> " . . . Manmohan Singh, of Taraf Satrakhani, now claims to be a Rajput, regardless of the fact that a few years ago his grandfather wrote himself down in public documents as Bhumij. I mention this instance as an illustration of the facility with which brevet rank as a self-made Rajput may be obtained. Manmohan Singh keeps a Brahman to support his pretensions, and professes to be very particular in all matters of ceremonial observance. His descendants will doubtless obtain unquestioning recognition as local Rajputs, and will intermarry with families who have undergone the same process of transformation as themselves" (Risley, 1891: Vol. I, 127).

It is interesting to note that, not quite satisfied with attaining the status of Dashmahal Rajput class, the father of the present *Taraf Sardar* of Satrakhani arranged the marriage of one of his daughters with one of the socially "degraded" and economically poor branches of the very high status Saraikella Raj family. This marriage, which involved a lot of expenditure, was arranged with the hope of sharing a portion of the glory of the high status of Saraikella Raj, in however diluted form it might flow to Satrakhani through the veins of a bastard lineage.

The mobility operations described above involve narrow lineages or single families in their individual capacities, trying to move up on the social ladder by dissociating themselves from the main body of the tribe. There have been, on the other hand, concerted moves on the part of the tribe as a whole to reform itself in the hope of gaining recognition as a higher Hindu caste, preferably as Kshatriyas. Before we deal with these reformist mass movements, let us discuss the role of the Raja in setting a higher and more complex standard of life in the Pargannah.

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Upgrading or universalisation of regional culture

Besides his political and economic roles in the Pargannah the Raja set down the highest standard of cultural style in the region as patron of Brahmanism and in the secular sphere as well. As many as forty-seven villages in Barabhum were presented to the Brahmans of various orders as *Brahmottar* and *Debottar* grants. The Raja maintained the following categories of priestly offices: Kula Purahit, Kula Guru, Chakrvarti, Deogharias, Sabha Pandit and Grahacharya—all belonging to so-called "pure" Brahmans either of the Utkal or Bengali Rarhi variety. The Raja had two guardian deities of importance—Brindaban Chand (i.e., Krishna) at the palace temple and a Tantric goddess of Chamundi locally known as Koteswari, in the traditional sacred grove of the Bhumij at Bhuni.

The members of the Raj family, as Rajput Kshatriyas, have to go through initiation to the sacred thread and all their rites of passage are guided by the Brahman priests of the highest order following the Vedic *Mantras*. The Raja also sponsored a number of gorgeous religious festivals among which *Ind Parab* and *Durga Puja* were the two most important ones. These festivals attracted people from all over the Pargannah and the fief holders used to come on horseback with open swords to join the procession with the Raja in the *Ind Parab*. Female visitors to the *Ind* festival used to carry with them seedlings from their sacred *Jawadali* baskets, connected with tribal *Karam* festivals in their own villages. These seedlings would be thrown at the *Ind* posts while they were being raised, with the hope of receiving the blessing of Indra, the King of the Gods, on the crops (Sinha, 1958 : 35). On the same day, again, villagers throughout the Pargannah used to plant branches of *sal* trees in their agricultural plots to invoke supernatural blessing on their agricultural operations. These are interesting cases of the meeting of the simple village traditions and the elaborate rituals of the Raja. By locating the temple of his goddess (Koteswari) in the tribal sacred grove at Bhuni, or by patronising the tribal festivals of *Delde Buru* in the village of Rupsang, the Raja raised the importance of these local sacred sites of the respective villages to a pan-Pargannah level of importance and consequent elaborations. There was the widespread belief in Barabhum that the Raja rules on behalf of god Brindaban Chand and goddess Koteswari and as such the Raja shared a good deal of divinity in his person. The human congregation in Barabhum was thus bound by a moral order of shared sacred ideas and sentiments with the Raja as the pivot.

We may now present some idea of the secular phase of the style of life of the Raja. The palace, which is also described as *Garh* or fort is bound on all sides by high walls. Within the compound itself there is a large tank where the Ranis used to enjoy bathing unobserved by outsiders. Among the many rooms in the palace are: the coronation room of the Raja (*Patghar*), his personal room, audience room or *Vaithak khana*, the office room (*Kacharimela*), room for each of the Ranis, a room for the Raja to retire alone if he is angry with his wives (*Gosaghar*) and so on. Among his servants were the *Duari* (gatekeepers), *Tel Makhani* (oil massager), *Dhuti Kochani* (one who dresses the *dhuti* cloth), *Khaoas* (food tester, as a precaution against poisoning), etc. Formerly it was the custom to play on *saina* (a type of clarionette) at intervals throughout the night for the Raja's entertainment. The Rajas had a flair for patronising concubines, dancing girls, and wrestlers. It was expected by the subjects that the Raja should be courageous, powerful, romantic, gorgeous and whimsical,

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while he, befitting the standard of the true "Rajput," should also be deeply devoted to the gods, and be a generous protector of his subjects.

It is of interest to note how the chiefs of the lower order imitated the ritual and secular standard of the Raja in an attenuated form, cut to the sizes of their economic capacities. All the *Taraf Sardars* sponsored *Durga Puja* by making clay images of the goddess, maintained priests who were offered gifts of land, put on the sacred thread (but not always going through an initiation rite) etc.

In the image of the Raja's *Garh* the *Taraf Sardars* used to have enclosed household compounds where the arenas of the womenfolk were sufficiently excluded from access to outsiders. These chiefs were also indulgent in the matter of keeping concubines and dancing girls.

The same image ran through, in an even more diminutive form, to the level of the village headman or *Ghatwal*. With his limited resources he would perform *Durga Puja* with a small earthen pot (*ghat*) representing the goddess. He would avoid manual labour in the field but would go personally to his fields to supervise agricultural operations. The female inmates of his house could go out to any house in his own village, but would never go as far as the weekly market. Even at the level of headman, these fief holders used to be called "Raja" (King) by their immediate neighbours, and the lower class of peasantry, belonging to the other castes would, half-mockingly and half-seriously, flatter even the ordinary Bhumij cultivators by calling them "Raja Lok" (of the King's class).

The Raja and the State thus set a standard for the emulation of a complex tradition which is also locally regarded as "the Rajput tradition," strongly supporting Brahmanical traits. And this percolated down to the level of the ordinary Bhumij cultivator. In this general universalisation of culture, both importation of Brahmanical traits and syncretisation of the Brahmanical with the local Hindu and tribal traditions, have played their parts. It should be noted that even in his eagerness for social upgrading the Raja could not ignore the tribal gods and rituals and the associated priesthood.

Social mobility of the Bhumij masses

This leads us to examine the process of emulation of the 'Rajput" model by the ordinary Bhumij peasants through concerted mobility movements. The other *Taraf Sardars* of Barabhum did not have the economic resources of the level of the Satrakhani (*supra*: 16) to attract Brahmans of high order to come to their service and to devise a suitable myth of origin. These *Taraf Sardars,* unable to dissociate themselves from the main body of the tribe, took the initiative for the tribe as a whole to be regarded as Rajput Kshatriyas, with the support of floating Brahman Pundits of a lower order. This involved meetings of the Bhumijes over a large territory, even transcending the limits Pargannah Barabhum. The slogans raised included the following prescriptive and proscriptive elements. The prescriptions included employing Brahman priests and Vaishnava preceptors in the rites of passage, learning to read the sacred scriptures like the Ramayana, the Mahabharata and so on. The main taboos were: ploughing with the cow, drinking wine, taking chicken, marriage by elopement, widow remarriage and group dancing by the women. In these meetings they used to make frequent reference to the "heroic Kshatriya tradition of the past" from which they had fallen in the recent years. This movement thrived very successfully, with occasional setbacks, between 1921 and 1947, and the Bhumij were shocked in 1951 when they

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were labelled as "Scheduled Wild Tribes" in the electoral rolls. Between 1952 and 1960, however, the interest in Rajput identification has considerably waned. This is partly because the leaders of the movement have realised the advantages to be gained from the Government by belonging to the tribal category. They have also become aware that Rajput standards are going out of fashion among the people who now wield power, money and "culture" in their mixed social environment. When I participated in one of their meetings in June, 1958 I found that the speakers only paid lip service to Kshatriyahood and the leadership had also shifted from the *Taraf Sardar* to the modernised commoners with initiative. This meeting mainly outlined secular goals such as economic uplift, employment, education, etc., and Rajputhood made a curious compromise with tribal affiliation by making a common cause with the Mundas from whom they wanted to be dissociated all these years. In this compromise they have taken the hybrid label *Bhumij Kshatriya Adivasi.* I have written in a previous paper that this secular phase of social movement of the Bhumij has not gained as clear a grip on the minds of the Bhumij as had the Rajput Kshatriya myth (Sinha, 1959). It is to be marked that it was this myth and looking up that helped the Bhumij in withstanding all the pulls of proselytising Christian missionaries. And it is the same aspiration that kept them apart from the general trend of the pan-tribal Jharkhand movement.

While reluctantly falling in line with the less Hinduised tribes like the Santal, Ho or Munda today, the Bhumij continue to carry the burden of their frustrated aspiration to be regarded as Rajputs. By stepping into the Bhumij country one can immediately smell the mood of decadent aristocracy and a feeling of predestined fall from the crest of the past that has paralysed the initiative of the Bhumij in their competition with the less aristocratic peasants like the Kurmi or the tribal Santal. We shall come across similar decadent moods of frustration among a few other tribal groups as we move along with a quick review of the comparative material.

III

Comparative Notes

Before making further analysis of the data on Barabhum estate in relation to the Bhumij tribe, let us briefly review some comparable cases in Manbhum district itself and then, in some other areas in tribal Central India.

The Manbhum estates

Of the revenue paying estates in former Manbhum district Panchet is easily the largest, both in area and in revenue demand. It includes no less than nineteen out of the thirty-nine Pargannahs which make up the district area and covers 1,650 square miles in Manbhum alone. The remaining Pargannahs of the district constitute each, with two exceptions, single estates. They range in size from a large estate like Barabhum which covers 600 square miles to a petty zemindary like that of Torang, barely eleven miles in extent.

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As he has been stated before, the Zamindars of Manbhum can be classified status-wise into at least four classes, given below :

Panchet, Patkum, etc.	The highest class Rajputs
Barabhum, Manbhum (Manbazar), etc.	Namahal Rajputs
Baghmundi, Jhalda, Begunkudor, etc.	Dashmahal Rajputs
Torang, Matha	Thakur, Manki etc. of Ataisha Bhumij class

Most of these estates share a number of characteristics with Barabhum estate. Settled agriculture with plough provides the requisite technological base for the accumulation of wealth in these Zemindar families, and the frontier vassals or subordinate chiefs maintain considerable autonomy in their own territories. The villages are grouped in a hierarchic order of territorial units in terms of an increasing series of *conventional* number of villages : 12 in the area of a *Manki,* 24 in the area of a *Thakur*, and 84, in the minimum, forming a Pargannah. These conventional numbers, particularly 12 and 84, have quite a widespread distribution througout Central India and even farther North West in Rajasthan (Wills. 1919 : 213). In the largest estate of Panchet, however, the earlier systematic hierarchic arrangement has been replaced by a system of semi-military, semi-police chieftains under the direct control of the Zamindar. In Patkum there used to be as late as 1797 12 *Taraf* divisions as we found in Barabhum (*supra* : 7).

All these Zemindars, again, like the Raja of Barabhum, are great patrons of Brahmanism, through generous land grants to the Brahmans, acceptance of the ritual standards of "Rajput Kshatriyas" under Brahman priests, and are supposed to rule over their respective territories on behalf of a Brahmanical god or goddess. Worshipping the clay image of Durga is a universal feature among these Zemindars as is also the observance of the Ind or Chata festival in which an umbrella, fixed at the top of a long pole, is raised in obeisance to the royal god.

In spite of their enthusiasm for the Sanskritisation of their rituals, these Zemindars continue to lend support to the worship of old tribal gods in their own territories. The chief of Baghmundi, for example, worships the tribal god Marang Buru and goddess Chuprungi as the Presiding Deities of the Zemindar's lineage.

No information is available on the relation between clan and traditional administrative territories in the zemindaries of Manbhum, other than those of Barabhum (*supra* : 9-12) and Baghmundi.

The resemblance to Munda type clan-Parha organisation (*infra* : 23) is most marked in the case of the Raja of Baghmundi. The Baghmundi estate is today composed of five groups of villages, one of these being held directly by the Zemindar himself. The other four areas are controlled by the Mankis on small rentals fixed in perpetuity. Conventionally, each of these Mankis occupies 12 villages while the Zemindar, in his turn, exerts direct control over 36 villages, making a conventional total of 84 villages for the Pargannah of Baghmundi. Each of these Mankis belongs to the Sandil (or Ubursandi) clan of the Bhumij tribe (who are also known as the Munda in this area) with their respective distinct ossuaries situated within their own jurisdiction.

The Raja of Baghmundi also belongs to the Sandil clan whose ossuary lies within a mile of his headquarters village. There is a tradition in the Pargannah that the four lineages of the Mankis are derived from four brothers of whom the ancestor of the Manki of Suisa was the eldest.

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There is also the alternative legend that originally there were five brothers and that the Raj family is descended from the eldest brother.

As regards the tribal affiliation of these Zemindars of Manbhum, the possibilities of Munda or Bhumij ancestry is quite transparent in the cases of Torang, Baghmundi and other zemindaries of Dashmahal group (Nandjee, 1883). The origin of a few other estates in Manbhum, however, is not linked with the Bhumij tribe. Manbhum or Manbazar Raj is associated with the Kurmi and the estates north of the Damodar with the Bhuiya castes (Coupland, 1913 : Chapter XI).

The Munda Raj of Chotanagpur

The case of emergence of kingship among the Munda of Ranchi is too familiar to the student of tribal ethnography of Central India through the writings of Dalton (1960 : 164-168) and Roy (1912 : 136-140) to need an elaborate treatment here.

The Munda, who subsist principally on settled agriculture with the plough, live in the eastern half of Ranchi. The Munda society, like the Bhumij, is organised into groups of exogamous, patrilineal totemic clans whose members live in distinct territorial clusters around the ancestral village in which the clan ossuary is located.

Traditionally it is said that the Munda socio-political organization did not stretch very far from the jurisdiction of a clan, known as Patti or Parha, except for marriage negotiations. The village had its headman Munda, who was also often the *Pahan* or the priest of the village, and the *Manki* was at the head of a Parha or Patti, conventionally consisting of twelve villages. The village chief, *Munda,* and the *Manki* were regarded as chiefs among equals and did not have much economic remuneration on account of holding their respective offices. It has been stated by Dalton, Risley and Roy that the kingdom of Chotanagpur came into being through an agglomeration of a number of such clan-based territorial clusters.

The exact historical sequences of the origin of this Raj family is wrapped in mystery. The origin myth which has been detailed by Dalton and Roy (Roy, 1912 : 136-140), ascribes the origin to the union of a serpent God Pundarik Nag (in the form of a Brahman) with a Brahman girl. The latter gave birth to a child near Suitambe, a village in Ranchi district, while out on a pilgrimage with her husband from Benares to Puri. Reared by Madra, a member of the Munda tribe who was also the *Manki* of a Patti, the child, who subsequently came to be known as Phani Mukut Rai, was allowed to succeed Madra in Mankiship of his Patti. Later on, all the Parha chiefs assembled to elect Phani Mukut Rai as their Supreme Chief or Raja.

It will be noted that this origin myth, widely prevalent throughout Chotanagpur, does not entail any mass immigration of an aggressive military group displacing the authorities of the autochthones in the area. Judging from parallels elsewhere in Tribal Middle India, one would naturally suspect, in line with Dalton, Risley and Roy, that the myth is a rationalisation, in terms of later Brahmanical elaborations connected with the Rajput myth, in the process of internal development of the Munda society towards the emergence of kingship.

The Raj family of Chotanagpur claim to be Nagvanshi Chhatris and perform all the necessary rituals of the ' twice-born" Rajput under the guidance of Brahman priests. The extent of patronisation of the Brahmans by the Raja of Chotanagpur would be apparent from the grant of nearly 134·89 square miles as privileged *Brahmottar, Debottar* and other *Brit* grants to the Brahmans (Roy, 1912 : Appendix xliii-xliv).

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The Raja of Chotanagpur, unlike the smaller Raja of Barabhum, chose, in course of time, to let the more aggressive immigrant Hindus hold the bulk of service tenures or *Jagirs* around his headquarters. This rudely disturbed the indigenous arrangement. However, in the outlying frontier tracts of Panch Pargannah, the relation with the subordinate fief holders or Zemindars continued to be of the traditional kind. These zemindary tenures are regarded as ancient as the Raj of Ranchi itself. And there is clear evidence that these Zemindars, like the family of the Raja, were derived from the Munda community. The internal territorial organisation of Tamar closely parallels that of Barabhum in that the zemindary is divided into a descending territorial hierarchy: Zemindar—*Thakur—Manki—Munda* (chief of a single village). Above the Zemindar is, of course, the Raja of Chotanagpur. The chiefs of each of the above levels of territorial unit belong to a nearly endogamous social class and Brahmanic and Rajput emulations increase as one moves up the hierarchy. The chiefs of various order in the district of Ranchi are maritally connected with similar levels of chiefs in Manbhum district: the Raja of Chotanagpur with Panchet and Ichagarh Zemindars, Tamar with the Dashmahal Zemindars, the *Thakurs* and *Mankis* under Tamar with the *Ataisha* Bhumij families of the order of *Manki* and *Taraf Sardar*.

The Gonds and their medieval kingdoms

We may now take up the case of the Dravidian-speaking Gonds who had developed, around the fourteenth and fifteenth centuries, kingdoms of much larger extent than the Munda or Bhumij kingdoms of Chotanagpur. Numbering about four millions, they are spread thin over a large territory in Central India, of whom about three million live in the state of Madhya Pradesh. The Gonds are found at various levels of economic development and acculturation—depending upon the nature of ecological isolation—over the vast stretch of their habitat. The bulk of their population are settled cultivators, who use the plough, whereas the tradition of slash and burn cultivation is still alive among the isolated Hill Marias of Bastar.

Like that of the Mundri tribes, the Gond society is based on initially localised totemic clans. These clans, unlike the Mundari clans, have a frequent tendency to cluster as phratries or even to be grouped into two exogamous moieties (Russel and Hira Lal, 1916, III: 62-72). Stephen Fuchs observes that the two different systems of social organization, namely territorial and genealogical, merged. Thus the territorial unit of Garh was the same as the territorial unit of a clan or *Gotra* and although the clans are now quite dispersed the clan members are aware of their original *Garh* affiliation which guides their funeral ceremonies (Fuchs, 1960: 162-163). Fuchs further remarks: "There is little doubt that this original territorial group system of the Gond was somewhat modified in the whole of Gondwana, and gradually developed into the present *Garh* system through the influence of the Rajput soldiers and landowners domiciled in the Gond area" (*ibid.*: 138).

According to Russel and Hira Lal (1916, III: 44-47) and Bishop Chatterton (1916: 9), the four independent Gond kingdoms arose in Gondwana 400 years ago more or less simultaneously, with capitals at Garha, Deogarh, Kherla and at Chanda. These kingdoms lasted for nearly 400 years, accepting nominal suzerainty of the Moghuls during the reign of Akbar, and ultimately fell to the raids of the Marathas in the seventeenth century.

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It is of interest to note that one semi-Rajput dynasty, the Kalachuri kings of the Haihaivansi line reigned in the territory for more than two centuries before the Gonds came into power. Their capital was at Tewar or Triari lying only four miles beyond Garha. The legend goes that Jadurai, the Gond hero who overthrew the Kalachuri Raja, began by entering into the service of the Kalachuri Rajas.

It was an important turning point in the history of the kingdom of Garha, when King Sangram Shah manipulated the marriage of his son Dalpat with Durgavati, the daughter of the Raja of Mahoba, a Chandel Rajput of high status. The battle between Durgavati and the Moghul Viceroy of Malwa, Asaf Khan, has been amply recorded by Abul-Fazl, the Moslem chronicler of Akbar's reign. It is stated there that Rani Durgavati's kingdom of Garha contained as many as 70,000 villages (compare 596 in Barabhum, *supra*: 9) and the wealth of the Gond queen could be gauged from the fact that Asaf Khan's army looted "101 cooking pots full of large and valuable gold coins besides jewels, gold and silver plate and images of gods." There were also 1,000 elephants.

Sleeman says about the method of government of these Gond kings: "Under these Gond Rajas the country seems for the most part to have been distributed among feudatory chiefs, bound to attend upon the prince at his capital with a stipulated number of troops, to be employed wherever their services might be required, but to furnish little or no revenue in money. These chiefs were Gonds, and the countries they held for the support of their families and the payment of their troops and retinue little more than wild jungles. . ." (Russel and Hira Lal, 1916, III: 41). Nevertheless, there are evidences of a certain degree of development of bureaucratised centralised machinery cutting across the principle of sub-infeudation, in the kingdoms of Garha and Chanda, the like of which we have not come across in the much smaller kingdoms in the Bhumij and the Munda countries of Chotanagpur (Wills, 1919: 257-258).

It may be noted at this point that the Gond Rajas, like other tribal chiefs described before, became patrons of Brahmanism and the Brahmans, and we have already mentioned the evidence of their Rajput aspiration in the marriage of the Gond prince Dalpat with the Chandel princess Durgavati.

We find reflections of these complex developments in the sphere of socio-political structure in elaborate development of the Lingo myth of creation which is recited by the members of the Pradhan caste who served as the minstrels of the Gonds just as the Charans were the bards of the Rajputs of Rajputana. The Brahmanical influence on the Gond kings is evidenced in many Hindu interpolations in the original Gond tradition by associating the cult of Lingo with Mahadeva and Parvati (Russel and Hira Lal, 1916, III: 48-49).

The epic songs recited by the Pradhans fall into two classes, i.e., those describing the glory of the Gond Rajas or Gondwani and Pandwani which is an astonishing variant of the usual stories from the Ramayana (Hivale, 1946: 78).

Although the great Gond kingdoms perished nearly two hundred years ago, social stratification and associated aspirations to be regarded as Rajput Kshatriyas still persists. Russel and Hira Lal find two aristocratic subdivisions among the Gonds, the Raj Gonds and the Khatolas, while the Dhur Gonds or ordinary peasants are of lower status. The Raj Gonds now rank with the Hindu cultivating castes and Brahmans accept water from them. They sometimes wear the sacred thread (Russel and Hira Lal, 1916, III: 63).

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Stephen Fuchs finds the following four ranked strata among the Gonds of Mandla district, from the highest to the lowest: the teetotaller Deo Gonds, the Suryavansi Raj Gonds who claim to be the descendants of Rama, the Suryavansi Deogarhi (the Sun-born Gond of Deogarh) and lastly the Ravanvansi Gonds. The two Suryavansi Gonds are also known as Raj Gonds and assume the rank of Kshatriyas. Fuchs observed that "recently any wealthy Gond proprietor willing to submit to Rajput caste rules could get his family admitted into the Raj Gond community" (Fuchs, 1960: 190).

We find among the Raj Gonds a reform movement, started about thirty years ago, for the complete absorption of the Gonds into the Hindu fold with the rank of Kshatriyas. The pamphlets itemising the ideology and the tenets of this reform movement glorify the past cultural attainments of the Gond Rajas and put the blame of the present degradation of their status on the Ravanvansi Gonds who eat beef, sacrifice pigs and chicken and drink liquor. It is stated that if the Gonds could give up these low habits they could recover their old status. There also have been several cases of Brahmans presenting the sacred threads to these Gonds (*ibid.*: 191-192).

This nostalgia for the past glory and involvement in Kshatriya movements reminds us very much of the case of the Bhumij. Hivale speaks of the satisfaction that the Raj Gond Landlord or Thakur derives from the poetical eulogies of the Pradhan bards: "The Pradhans talk of the Great Gond Rajas and the noble and generous tribe of which his Thakur is such a shining example" (Hivale, 1946: 50-51).

The Rajput chieftaincies of medieval and later Chhattisgarh

Since 1905, the Chhattisgarh group of feudatory states included 14 states under the British Government. These covered an area of 30,959 square miles and 1,618,109 people in 1901. While the majority of these states fall between 500 and 2,000 square miles in area, there are also the bigger states of Sarguja (6,055) and Bastar (13,002).

These chieftains were, in most cases, subordinate to the higher chiefs such as the Raj Gond Rajas of Mandla, Deogarh or Chanda or the Haihaivansi Rajputs of Ratanpur. Bastar alone seems to have remained intact from a very remote period without the territorial interference of a paramount power (De Brett, 1909: 8-9).

Instead of reviewing the situation in each of the 14 states, we shall examine the position of the old kingdoms of Ratanpur and Raipur and of the remote state of Bastar. Before doing this let us quickly reconnoitre the histories (mixed up with legends) of origin of some of these states.

Tribal connections with the lineage of the chieftains are most evident in the cases of Kawardha, Raigarh and Sakti where the Raj families are derived from the ancient Raj Gond Rulers of Gondwana. It is widely believed in their respective regions of Korea and Jashpur that the current regimes of Raksel Rajputs were preceded by tribal chieftaincies of the Kol and Dom tribes respectively. Khairagarh claims descent from the Nagvansi Raja of Chotanagpur and is thus probably related to the Munda. Besides these cases of possible on the spot growth of states, there are also evidences of conquest playing an essential role in giving shape to the present form of some states. The Raksel Rajputs from Plamau are believed to have conquered Sarguja from the local tribal chieftains and become overlords over Udaipur, Jashpur, Korea and Changbhakar (De Brett, 1909).

Let us now examine the structure of traditional Chhattisgarh in the

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medieval period under the Haihaivansi Rajputs. In doing this we shall depend principally on C. U. Wills' careful analysis of the available records on the old Rajput kingdoms of Ratanpur and Raipur (Wills, 1919).

A powerful Rajput family belonging to the Chedi dynasty ruled at Tripuri near Jabbalpore around the tenth century A.D. A descendant of this Chedi family named Kalingaraja, settled at Tuman in modern Bilaspur district. His grandson, Ratnaraja, founded Ratanpur, the then capital of Chhattisgarh. The dynasty continued to rule vigorously for some six centuries. About the fourteenth century it split into two portions, the elder branch continuing at Ratanpur which was still the capital of Chhattisgarh, while the younger ruled in semi-independent state at Raipur. About the end of the sixteenth century the rulers of Chhattisgarh acknowledged the suzerainty of the Great Moghuls and thereafter sank into complete obscurity and were finally deposed by the Marathas around 1745 A.D.

By comparing the past administrative system of Chhattisgarh rulers with those of the present chieftaincies, Wills came to discover the following symmetrical arrangements that used to guide the territorial organization in this area :

"(a) The whole country was divided into two kingdoms—a northern kingdom with capital at Ratanpur and a southern one with its capital at Raipur.

"(b) Each kingdom or Raj was subdivided into districts known as *Garhs* or forts, conventionally supposed to be eighteen in number. The whole owed allegiance to a Rajput king.

"(c) Each district or *Garh* was conventionally supposed to contain 84 villages, whence the term *Chaurasi* is derived. It was held by a *Diwan* or *Thakur,* a local chief whose power within his territory was of the widest kind.

"(d) Inside the *Garh* were smaller units of *Taluqs,* each conventionally supposed to contain 12 villages and therefore known as *Barhons.* Those were held by *Daos* or *Barhainihas,* minor chiefs. . . .

"The *Dao* was ordinarily the Headman or *Gaontia* of the village where he resided, the other village headmen of his *Taluq* being separate *Gaontias* who acknowledged his authority. Similarly the *Diwan* was the *Dao* of the particular *Taluq* in which his headquarters were situated, while his outer *Taluqs* were allotted to chiefs of the second degree subordinate to him. Lastly the Raja kept under his direct control the Headquarters *Garh,* while the other *Garhs* of his Kingdom were allotted to the chiefs of the other rank. Sometimes the chiefs of *Garhs* were kinsmen of the Raja ; minor chiefs of *Taluqs* were similarly related in some cases to the lord of the *Garh,* and the *Gaontias* in their degree were sometimes related to the chief of their *Taluq*. . ." (Wills, 1919 ; 199).

Wills was fully aware that the above was an "ideal model" or a "theory" and that it was nowhere exemplified in full detail. This ideal model for Chhattisgarh fits fairly closely our data on chieftaincies derived from the Bhumij, the Munda or the Gond bases. This widespread uniformity in the *ideal* model of territorial system cannot be explained away as cases of independent arrivals at the same socio-political solution. An ideal model, expressed through such conventional numbers of territorial units—12, 84, 18, etc.—must have had widespread diffusion throughout this territory. It should be mentioned here that the conventional unit *Chaurasi* (84 villages) occurred frequently in Rajasthan, the universally acclaimed headquarters of the highest order of Rajputs (Tod, 1920, I : 166).

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Wills finally labels the prevailing territorial arrangement in medieval Chhattisgarh as "feudalism superimposed on an earlier tribal base" and finds it to be a great contrast to the old Hindu kingdoms which were essentially monarchical and bureaucratic (Wills, 1919: 255-257).

We end our comparative survey with the state of Bastar, the largest member of the modern Chhattisgarh group of states. With an area of nearly 14,000 square miles it has a population of only 524,721 (as of 1931), making a density of only 34 to the square mile. Out of these, nearly 75 per cent belong to the "tribal" category, mostly of the Gond family, variously known in this state as the Muria, Maria, Dorla and Koya.

The present ruling family of Bastar is regarded as having descended from the Kakotiyas, who were feudatories of the Chalukya kings in Warangal. Defeated by Ahmad Shah Bahmani early in the fifteenth century, Annamdeo, the surviving brother of Raja Prataprudra fled across the river Godavari into Bastar and set up his capital at Dantewara, by subjugating the local chieftains. It is stated that portions of Bastar under these local chiefs were already feudatories of the Kakotiyas, before the coming of Annamdeo. It is said that eighteen *Garhs* or Pargannahs around Baredongar in Kondagaon were conquered by the Kakotiyas of Bastar from the Somvansi Rajput Raja of Kanker. One finds the ruins of an earlier and advanced Hindu civilization at Barsur and at Dantewara under a Telugu line of Nagvansi kings who ruled these areas around the eleventh century A.D. The Bastar Raj family claims its descent from the Pandu King Birbhadra of Delhi. The legendary nature of this claim is too obvious to need further probing.

The *Khalsa* or directly controlled territory of the Raja was located around Jagdalpur, the capital town. This *Khalsa* tract used to be protectively surrounded on the north, west and south by seventeen or eighteen zemindaries, among which only four survived till recent years. Of these, Sukma Zemindars are regarded as Kshatriyas, and of even greater antiquity than the Raj family of Bastar. The Zemindars of Bhopalpatnam are Raj Gonds and are perhaps also of earlier origin than the Kakotiya Raj of Bastar. In Kutru, moreover, there remain three or four sub-zemindars under the Zemindars. According to Grigson: "All these facts indicate that before Annamdeo's arrival there was a nominal suzerainty of Warangal over most of Bastar, the real authority resting with local chiefs, or in the heads of the old tribal organization that was so marked a feature of the medieval kingdoms of the eastern Central Provinces and some of the Chotanagpur and the Orissa estates" (Grigson, 1949: 4). In Glasfurd's report of 1862 we find that of the 43 non-zemindary subdivisions of Bastar, 17 were called Pargannahs and 26, *Garhs* (*ibid.*: 33). Grigson finds a fair correspondence between the territorial unit of Pargannah and clan among the hill Marias of Bastar (*ibid.*: 288).

The most striking feature about the Bastar State is the completeness of interaction between the cults of the tribals and those of the Raja. The cult of the royal goddess Danteswari, Manikeswari or Maoli has spread over wide areas in Bastar although when she is worshipped by the local tribal priests, the rituals become necessarily simple with local non-sanskritic connotations. On the occasion of Dassehra festival it is customary for all these village priests to bring the emblems of their gods and goddesses, and to assemble these around the emblem of the royal goddess Danteswari at Jagdalpur. On the other hand we find the tribal log god is gaining a place of nearly equal status in the palace cult as that of Danteswari, by assuming the name Patdeo. It is in the Dassehra festival,

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again, that the Raja has to offer *puja* to Danteswari as her chief devotee and on alternate days the goddess and the Raja are carried in a swing on a huge chariot pulled by the Maria and Muria tribals of Bastar. The Raja is practically regarded as an incarnation of Danteswari and it is believed that he rules Baster on behalf of the goddess. Elwin mentions that the Murias believe so strongly in the divinity of the King that "they greatly resent the Maharaja leaving the state even for a short time. His absence means a withdrawal of divine protection from cattle, crops and people" (Elwin, 1947 : 183).

The Raja's role as a regulator of social customs will be apparent when we learn that he had the authority to auction widows and divorced women of the Sundi, Kalar, Dhobi and Panara castes. The chief also could sell the headmanship of various castes, and had the authority to upgrade the members of a low caste by conferring the sacred thread (DeBrett, 1909 : 64-65). Being so vitally connected with the rule of Kshatriya Rajas, the major tribes and castes in Bastar have been drawn into a perpetual upward drive in the direction of Kshatriyahood—a feature which has become so familiar to us through the Bhumij, Munda and Gond data. Roughly, the ethnic groups of Bastar are stratified from the highest to the lowest as follows : "True" Rajputs, Dhakars, Halbas, Bhatras, Murias, Bisonhorn Marias and hill Marias. This list, of course, does not include a number of other tribes and castes in Bastar (See also Majumdar, 1939 : 106). The hill Marias, on settling down in the plains to the south of Abujhmarh, tend to become Bisonhorn Marias. In the vicinity of Jagdalpur Tahshil the Bisonhorn Marias wish to be identified as Murias. In the border of the Muria and the Bhatra tracts, some Murias claim to be known as Bhatras, while the Halbas wish to be regarded as full Kshatriyas of the status of the Raj family.

IV

Conclusions

We have discussed above, with a number of examples, how the various tribes of Central India such as the Bhumij, Munda, and the Gond have been influenced by the formation of states in their respective territories. If we had extended our enquiry to the former feudatory states of Orissa, we would have come across similar developments among the Saura, Bhuiya and the Kandha.

The actual process of formation of the states, as far as could be ascertained, has taken varied courses in the different instances discussed above. Some, like the Munda Raj of Chotanagpur, the Bhumij state of Barabhum and the Raj Gond kingdoms of Gondwana, appear to have emerged mainly through internal developments out of a tribal base. There are also cases of immigrant Rajput adventurers gaining power in the tribal tract by manoeuvering the narrow-range clan-bound tribal chieftaincies and in a few cases, even by conquest (for example, Bastar, Surguja, Jashpur and so on). There is, however, no tradition or record of large-scale invasion of the agriculturist tribal territory by aggressive nomads which could lend support to the typical "conquest theory" of Gumplowicz or Oppenheimer which posits that invasion of peasants by hordes of herdsmen is an essential historic prerequisite to the formation of state (Oppenheimer, 1914 : 51-81).

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Whether a particular state is primarily an internal growth or the creation of an adventurous Rajput or pseudo-Rajput lineage, the final forms of the political structure of these chieftaincies in Central India look more or less alike in essential features, namely, a feudalistic superstructure on a tribal base. While the immigrant adventurous Rajputs and their associates had to adjust themselves to the *in situ* clan-based tribal territorial system, internal developmental processes in the tribal belt, in their turn, took the form of aspiration to meet the Rajput model (at least the version that was accessible nearby) with the necessary adjustment. The widespread prevalence of certain conventional numbers such as 12, 84 and 18, in organizing the territorial segments of a state indicates a general sharing of certain ideas throughout Central India. In the absence of any definite record of large-scale southward migration of Rajputs, this unusual spread can only be explained through the concept of "stimulus diffusion" of an idea as defined by Kroeber (1948: 368-370).

Besides the conventional territorial system, a whole set of ideas such as the high position of the Rajput in the Varna order of the caste system, their conventional qualities of valour, chivalry and glamour, the role of the Rajput as the defender of Brahmanism, patronisation of a key symbolic festival (Dussehra or Durga Puja, and so on), have an extensive distribution as a model of social and cultural aspirations throughout Central India. In specific detail, however, the concrete Rajput models of emulation differed from area to area. We should also mention that Brahman priests in search of new clients in the growing aristocratic strata in the tribal frontiers perhaps played a more important role in the diffusion of the Rajput model, both on the sacred and secular levels, than the Rajputs themselves.

The diffusion of the Rajput model of state as also the indigenous developmental processes could gain ground only among those tribal groups like the Bhumij, Munda, Gond, or Bhuiya, who had attained the technological level of settled agriculture. In no case do we find a shifting cultivating group like the Juang (Orissa), hill Bhuiya (Orissa), Kharia (Manbhum), or the hill Maria (Bastar) developing a kingship supported mainly by their primitive technique of cultivation.[5] On the other hand, it is also true that cultivation with the plough is not a *sufficient* condition for the formation of states from tribal bases, for example, the settled farming Ho of Kolhan and the Santal of Santal Pargannah and the neighbouring districts. Stable occupation of a particular territory for a number of generations is perhaps another essential condition for the emergence of a state *in situ*. There are some evidences that the Santal had to migrate fairly fast from their original homeland in the Hazaribagh and have settled down in widely scattered blocks during the last two hundred years (Datta-Majumder, 1956: 23). The core of the Ho area was much too rudely disturbed by internecine wars among feudatory chiefs surrounding Kolhan.

That the clan seemed to have initially demarcated the lower levels of territorial organization is fairly well borne out by the data in hand among the Munda, Bhumij and the Gond among whom the superstructure of the state looks like a coagulation of clan-based territories. However, once the structure of the state had come into existence, the

[5] It is not being suggested that cultivation with plough is essential for the rise of kingship. Even slash and burn farming with digging stick and hoe can give rise to states if there are no plough technologies to compete with in the immediate environment (for example, the Maya, Aztec and the Inca states of Meso-America and the numerous kingdoms in Negro Africa).

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territories seemed to be regarded, from the top at least, mainly as military-administrative units, without reference to clan or caste. In the Bhumij and the Munda territories 5 as a conventional number is important in territorial organization. Thus there are the five Pargannahs under the Raja of Chotanagpur ; the zemindary of Panchet is also known as Pancha Khunts or the "five stripes" and Pancha Sardari or the five *Sadiyalis* under the *Taraf Sardars* in Barabhum. This conventional number of 5 is often associated with the myth that the five major segments of a state, including one originally controlled by the Raja, owe their respective origins to five ancestral brothers, among whom the most senior brother is the ancestor of the royal lineage proper.

Thus, although the cases studied lend support to the theories of Maine and Morgan stating that transference of organizing principle from "clan" to "territory" is one of the fundamental steps in social evolution (Morgan, 1878 and Maine 1888 : 72-74), links with the archaic clan organization, and the principle of mythical kinship still lingers on with the territorial organization in these states.

As regards the over-all nature of the kingdoms or chieftaincies of Central India, Wills seems to have said the last word : " . . . a system of feudalism super-imposed on an earlier tribal organisation." It should be noted, however, that the superstructure of Rajput model *par excellence* of Rajputana itself has not been regarded as strictly feudal by competent historians. A. C. Layall is of the opinion that the political system of Rajputana was essentially *tribal* and had not fully evolved to the state of feudalism. Nowhere, he writes, had "military tenure entirely obliterated the original tenure by blood and birthright of the clan" and that land-tenure had not become the basis of Rajput nobility—rather, "their pure blood is the origin of their land tenure." It is also stated by Layall that "it is universally assumed in every clan of Rajputana, that the chief and the ruler of the state is only *primus inter pares*" (Layall, 1875 : 203-264).

It is also true that these kingdoms were very different from the early Hindu kingdoms of India in the plains of Magadha, Bengal, Orissa and so on. These latter governments were in the form of a centralised, monarchical system operating with an elaborate bureaucratic machinery of military, revenue and administrative officials. Such machineries practically did not develop at all among the tribal-derived states of Central India, except to a very limited extent among the large Raj Gond kingdoms of Garha-Mandla.

The most striking and important impact of state formation on the internal structure of these tribes was, of course, the stratification of the hitherto egalitarian society into social classes. Social stratification follows mainly the lines of subinfeudation of territorial units. On the whole, power, economy (as defined in terms of land-holding) and social status have a fairly close correlation in the regional system of stratification. However, the final validation of status is in terms of kinship (fictitious or real), marriage alliance and ritual symbols. A poor person, related by kinship and marriage to wealthy "Rajput" families, gains considerable prestige from the right kinds of symbolic associations with the caste status of the Rajput. On the other hand, the Brahmans, who are the key social specialists in the validation of status, have been demonstrably affected by the secular lure of money and power. And this brings the status system more or less in line with the objective state of differentiation in power and economy.

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If we examine the case of the Bhumij of Barabhum along with that of the Munda of Tamar, we find that both groups, after running through the equivalent lines of local hierarchy, arrive at the next higher level (Panchet-Ratu) of all-Chotanagpur Division scope. These superior Rajas of Panchet and Ratu in their turn look up to the Rajput level of the larger chiefs of Orissa and Chhattisgarh. These latter Rajput aristocracies are aware that still higher status is accorded to some of the Rajput clans like the Suryavansi Sesodiyas of Mewar, Rajputana, on an all-India level. It should not be imagined, however, that there is a neatly worked out and universaly agreed upon status hierarchy for the Rajputs all over India, or even within Central India as a whole. We are not concerned here with the numerous competing claims for relative high caste status within the Rajput stratum among these kingdoms. Over and above these details of status controversies there is a certain degree of general consensus among the "Rajput" feudatory states and zemindary states of Central India as to the relative status of the various royal lineages tied in fairly stable clusters and classes of marriage alliances. Most of these look up to the Rajput princes of the Solar and Lunar branches in Rajputana as belonging to the highest order of Kshatriyahood. Tod writes: "From Rama all the tribes termed *Suryavansa,* or 'Race of the Sun', claim descent as the present princes of Mewar, Marwar, and Bikaner and their numerous clans; while from the Lunar (Indu) line of *Budha* and *Krishna,* the families of Jaisalmer and Cultch . . . extending throughout the Indian desert from the Sutlej to the ocean, deduce their pedigrees" (Tod, 1920: 55).

In other words, there is a hierarchic structural and ideological (mythical) link between the ordinary tribal Munda, Bhumij or Gond farmers of Central India and the Rajputs of the highest order in Northwest India. The myth of the Rajput standard of living and the structural framework of states ruled by Rajput and pseudo-Rajput lineages of various orders connects the tribal belt of Central India in a special way to the mainstream of Hindu civilization and its core sacred lore in the form of epics and puranas.

The way in which the upper strata of the tribal groups described above have been drawn to the generic Kshatriya-Rajput pool is perhaps not much different from the way in which the bulk of the now most highly esteemed Rajputs of Rajputana had been drawn into the Kshatriya fold from the original invading stocks of tribal Hunas around the sixth century A.D.:

"Probably it would be safe to affirm that all the distinguished clan castes of Rajasthan are descended mainly from foreigners, the 'Scythians' of Tod. The upper ranks of the invading hordes of Hunas, Gurjaras, Maitrakas, and the rest became Rajput clans. . .

"Such clan-castes of foreign descent are the proud and the chivalrous Sisodiyas or Guhilots of Mewar" (Smith, 1958: 191).

It is more or less the same way that the great builders of Khajraho temples emerged as Rajput Kshatriyas of Chandel clans out of a tribal base (*ibid.*: 191).

As to the cultural role of these states, they have not only propagated the standard Brahmanic socio-ritual forms, but have also universalized the local tribal cults to a grand level of elaboration, providing a rich regional flavour to the cultural pattern of a kingdom.

Our presentation so far may suggest a much too smooth ongoing process inevitably leading the tribes to the Rajput fold. There has been occasional and significant setback and reversal to this generic process,

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Navalakha's observations on the Bhils of Banswara may be cited in this connection. The Bhils of Banswara were finally subjugated by the Guhil Rajputs during the 18th century. The Bhils largely retired to the hilly and wooded interiors to escape the aggressive conquerors. "The Bhils who escaped to the geographically inhospitable interiors were motivated by their urge to preserve independence ; but their political structure was shattered and they were politically disintegrated. . . The Bhils eventually retreated to a comparative seclusion beyond the reach of the alien peoples and particularly of the arms of the state authority" (Navalakha, 1959 : 37-38).

It should be pointed out here that Hinduisation of the tribes has not been implemented through the structural medium of the states alone ; a good deal of it has been achieved through the spontaneous interaction of the Hindu artisan, cultivator and sacerdotal castes with the tribals, and this has not been covered in this paper.

We have so far viewed the tribals in the orthogenetic phase[6] of growth, spread and persistence of the traditional civilization of India. The tribes were moving up in terms of established social mechanism and towards goals clearly defined in terms of ideational and behavioral standards. With the merger of the feudatory chieftaincies, abolition of zemindaries and rapid encroachment of tribal life by the secular non-Brahmanical policy of the "welfare state" of India, the image of "the Rajputs" has been fast losing its glitter in the face of many concrete advantages received from the Government on account of the "low" tribal affiliation.

It is no wonder that in the last meeting of the Bhumij Kshatriyas I attended in 1958, little enthusiasm was observed for being recognised as Rajputs or for quoting sanskritic *mantras* in support of such claims. The concern was more for gaining some footing in the coming General Election and for competing with the hardheaded Mahato in education and economic prosperity (Sinha, 1959 : 28-32).

With the unfulfilled craze for Rajput recognition still lurking in their hearts and a residue of the broken landed aristocracy yet remaining in their midst, the Bhumij and the Raj Gonds find it hard to readjust to the current secular demands on them. These Hinduised tribals, in their aristocratic vacillations, stand to a distinct disadvantage in relation to the less Hinduised groups such as the Ho, Santal, sections of the Munda and the Gond and so on, who are building up the Adivasi Movement with secular goals, with a great feeling for the future.

We are not assuming that the general process of integration with the Hindu society will come to an end with the shattering of the state structures of great historic depth. The fact of state formation has already achieved the historic task of speeding up the dissemination of Brahmanical standards and of synthesising the latter and the tribal cults. The tribes and the Hindus already share too many common elements and there exists today too wide a range of contact between the tribes of Central India and the Hindu castes on the economic and administrative planes to facilitate the tempo of integration with the Hindu society. The steps through which the new (heterogenetic?) phase of integrative processes moves on remains to be investigated.

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[6] See Robert Redfield and Milton Singer, "The Cultural Role of Cities," *Economic Development and Cultural Change* (Research Center in Economic Development and Cultural Change, University of Chicago), Volume 3 (1954), Number 1, Pp. 53-73. Reprinted in *Man in India,* Volume 36 (1956), Number 3, Pp. 161-194.

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This inadequately documented and somewhat speculative and cursory essay has been attempted mainly with a view to attracting the attention of my colleagues in the field of tribal ethnography to fill in the major gaps in my presentation on the tribe-Rajput continuum in relation to the general study of Indian civilization. This is also a pointer to the fact that tribes should be studied not only as ethnic isolates interacting with other ethnic groups, but also within a spatial framework such as a Pargannah, Garh or a kingdom which has considerable historic continuity. This essay is also intended to stimulate an awareness in the research worker of the distinct orthogenetic and heterogenetic phases in the study of cultural transformation in tribal India.

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SECTION OF MEDICAL AND VETERINARY SCIENCES

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PRESIDENTIAL ADDRESS

THE PROBLEM OF CORONARY HEART DISEASE

At the outset I take the opportunity of expressing my heart felt thanks to the Executive Committee of the Medical and Veterinary Section of the Indian Science Congress for kindly electing me as their president this year.

I propose to speak to you today on a very important subject 'the problem of coronary heart disease'. You must have often heard in the newspapers of eminent men—politicians, educationists, professional men viz. doctors, engineers, lawyers, and big business men falling victims, in the prime of life, to coronary heart disease causing a great national loss that is hard to fill. A philosopher may think that life has its beginning and must have its inevitable end. But it does not behove a scientist to think in that vein. It is for him to discover the 'Elixir of life', something that will defer death and prolong the span of human life to one hundred years or more.

In fact during the last two decades, the discovery of the antibiotics and the application of the newer knowledge in epidemiology have led to the elimination of the various infectious and parasitic diseases that once used to take a heavy toll of human lives. With improved methods of rapid food production and food preservation and increased availability of food, diseases of malnutrition and deficiency diseases have disappeared. But nutritional problems of a different nature have appeared in the highly developed countries of the world like the U.S.A. and the U.K. Obesity is one of the problems and it is definitely due to eating in excess of what the body needs and to less physical activity associated with sedentary occupations and transport by cars.

During the last twenty years there has been a real increase in mortality from coronary heart disease in all the highly industrialised western countries of the world despite increased medical awareness, fashions in diagnosis and differences in the method of reporting. Evidences have been accumulating that the disease is on the increase in India with the growth of industrialisation in recent years.

Coronary heart disease has posed today a great challenge to the scientists all over the world and the task before them is to find out its exact etiology, prevent its incidence or delay its onset or course and thereby lengthen the span of human life.

Historical review

As far back as 1700, Bonetus described in the second edition of his book Sepulchretum the death of a middle-aged fat poet, in a few minutes, with 'distress in breathing' and subsequent findings at autopsy of almost

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completely occluded calcified coronary vessels. In 1761 Morgagni was not aware of the symptomatology of coronary heart disease. Heberden in 1768 coined the term angina pectoris to describe chest pain which was associated with a sense of 'strangling and anxiety' and occurred usually during walking, specially after a heavy meal, and disappeared with rest. He had no knowledge, however, regarding its relationship to heart disease. It was Jenner (1772), as quoted by Parry (1799), who was the first to recognise the cardiac nature of angina pectoris. Fothergill (1776) published case reports of angina pectoris with 'ossified coronary artery' and described myocardial scars. Black (1794) published similar reports. Weigert (1880), Cohnheim (1881) and Huber (1882) showed clearly the relationship between coronary artery occlusion and myocardial infarction and fibrosis.

But the first complete clinical description of sudden coronary occlusion was given by Herrick in 1912 and till 1926 the general medical practitioners could hardly recognise the disease in clinical practice.

Incidence of Coronary Heart Disease

Coronary heart disease has a world wide distribution. The incidence has been reported variously, not only from the different countries of the world but also from the different parts and the socio-economic groups of the same country. The sources of prevalence studies are usually (1) the hospital population, (2) survey of comparable groups of population, (3) mortality rate and (4) autopsy studies. Biörck (1960) has suggested several alternatives in the choice of comparable population such as (a) a sample of the whole population, (b) a sample of a community representing the whole population with reference to age, sex, occupation and mortality rate, (c) total population of certain age and sex groups in small communities, (d) a sample of one or several occupational groups. He stresses upon the importance of long term follow up studies in communities and occupational groups.

From a recent survey of 3,000 cardiac patients in New England, White (1951) reports an incidence of 48·5% of coronary heart disease. Wood (1953) reports an incidence of about 30% amongst the cardiac cases in the U.K. From a study of the hospital records, a number of Indian workers have reported the incidence of coronary heart disease amongst the cardiac patients as shown in Table I.

It is obvious from Table I that the incidence of coronary heart disease amongst the cardiac patients in the general hospitals of the different States of India varies from 10·2% to 16·9%. The range of variation is indeed insignificant. The low incidence of 6% reported by Devichand amongst the hill populations may be attributed to their low standard of living due to poverty. The high incidence figures of 23% reported by Malhotra, 21·6% reported by Wig et al are due to the inclusion in their series of cardiac patients seen in private practice and special cardiac clinics. The increased incidence of 26·6% reported by Gupta amongst the cardiac in-patients of the heart hospital is explained on the basis of selective admission of cardiac patients of the high socio-economic group.

It is relevant to mention here, that in an analysis of a recent personal series of 189 cardiac patients of the high and middle income groups, Banerjea (1960) observed an incidence of 40·7% of coronary heart disease. This figure is definitely higher than that (30%) of Wood (1953) in the U.K. and is not far short of the incidence of coronary heart disease (48·5%) in the U.S.A. as reported by White (1951). A survey of 1803

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TABLE I.

Showing incidence of coronary heart disease in the different hospitals of India.

Name of the City	Author	Year	No. of cardiac cases	Percentage Incidence of coronary heart disease
Madras	Sanjivi	1946	616	13
Bombay	Vakil	1949	1,800	13·5
,, ...	Samani	1956	2,081	12·1
Lucknow	Bhatia and Jain	1953	1,000	10·2
Delhi	Padmavati	1957	2,360	11·3
Amritsar	Malhotra	1951	692	23
Amritsar	Wig and Malhotra	1953	500	21·6
Simla (Himalayan Hills)	Devichand	1959	395	6
Calcutta	Banerjea	1960	2,651	12·1
,, ...	Gupta	1956	1,291 (out-patients)	14·4
,, ...	Gupta	1956	398 (in-patients)	26·6
Agra	Mathur	1960	—	16·9

unselected persons above the age of 20 years amongst the general population at Agra has been made by Mathur (1961) to study the prevalence of coronary heart disease. He gives an overall incidence of 1·6% and the highest incidence of 3·8% amongst the high socio-economic groups. Padmavati et al (1959) report an over all incidence of 0·7% in a population sample of 638 cases.

In a recent survey of 174 individuals in an industrial area near Delhi, with ages ranging between 15 to 59 years (only one being 75 years) of different socio-economic groups, Padmavati et al (1961) found only 1 case of coronary heart disease. This extremely low incidence was probably due to the younger age group of the series. In a study of 138 non-cardiac hospital patients of the age group of 20-80 years Banerjea (1961) observed evidence of coronary heart disease in 9 (6·5%). Such studies however are not likely to be helpful in a correct appraisal of the incidence of coronary heart disease.

Mortality statistics before 1920 rarely reported deaths from coronary artery disease. It is now the leading cause of death in the U.S.A., Canada, Australia, New Zealand and Finland. The mortality from coronary heart disease is one fourth to one tenth or even less than that in the U.S.A. (Keys 1956), amongst the Japanese (Kimura, 1956), the Bantus in the Union of South Africa (Bronte-Stewart et al, 1955), Guatemalan Indians (Mann et al, 1954), Nigerians (Mann et al, 1955), Yemenite Jews in Israel (Schindel, 1956), Italians, Sardinians in Italy (Keys, 1954) and the low income men in Madrid (Keys et al, 1954).

Information about the mortality from coronary heart disease amongst the general population in different parts of India has not been available. No such record happens to be maintained by the health department of the Municipal corporation of the big cities of India (except Nagpur). Some statistical data regading the total number of cardiac deaths and the number of deaths from coronary heart disease have been obtained from the various medical college hospitals of India. These data are shown in Table II.

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TABLE II.

Showing the number and percentage of deaths from coronary heart disease amongst the total number of cardiac deaths.

Source of data	Year	Total No. of cardiac deaths	No. of deaths with percentage from coronary heart disease	
Madras Govt. Medical College ...	1952-60	2340	441	18·8%
Madras Stanley Medical College ...	1959-60	310	18	5·8%
Pondicherry Medical College	1959-61	20	3	15·0%
Vellore Christian Medical College	1959-60	732	134	18·3%
Mysore Karnatak Medical College	1960-61	37	2	5··4%
Andhra Pradesh Guntur Medical College ...	1955-61	90	5	5·5%
Hyderabad Gandhi Medical College ...	1960-61	79	25	31·6%
Nagpur Medical College ...	1954-60	496	69	13·9%
Lucknow K. G. Medical College ...	1956-60	385	90	23·3%
Balarampur Hospital ...	1946-60	246	107	43·4%
Gwalior G. R. Medical College ...	1957-60	223	29	13·0%
Patiala Medical College ...	1956-60	301	31	10·3%
Amritsar Medical College ...	1950-60	393	91	23·2%
Agra S. N. Medical College ...	1947-60	629	72	11·4%
Calcutta Medical College ..	1956-60	1006	130	12·8%

The data available from the model vital and health statistics unit, Nagpur Corporation are shown in Table III.

TABLE III.

Showing the total number of cardiac deaths and the number and percentage of deaths from coronary heart disease.

Years	Total No. of cardiac deaths	No. of deaths from coronary heart disease and percentage	
1957-60	514	96	18·6%

The statistical data available from the Central Bureau of Health Intelligence, regarding deaths among in-patients recorded in the hospitals and dispensaries of some of the State Governments due to cardiovascular diseases and coronary arterial disease for the years 1955-59 are given in Table IV.

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TABLE IV.

No. of deaths among in-patients of the hospitals and dispensaries of some of the Indian States, due to cardiovascular and coronary arterial diseases.

State	Year	Total No. of deaths from cardiovascular disease	Total No. and percentage of death from coronary arterial disease	
Madras ...	1955-59	6,616	628	9·5% approx.
Punjab ...	1954-58	1,063	172	16·2% ,,
Rajasthan ...	1955-59	1,140	60	5·3%
Uttar Pradesh ...	1953-54 and 1956-57	1,092	178	16·3%

It may be pointed out here, that the data from Madras and Punjab relate to the States before re-organisation. Similar information from other States is not available.

It is evident from a careful survey of the above tables that the percentage of mortality from coronary heart disease amongst the cardiovascular deaths varies widely in the different parts of India. This variation may to a certain extent be due to differences in diagnosis and in the mode of certifying. It is quite possible, however, that this is chiefly due to differences in the socio-economic status and dietary habits of the people in the areas concerned.

Autopsy incidence of coronary heart disease.

Studies on this aspect are very scanty in India. The data that have been available from the Medical College, Calcutta, the Andhra Medical College, Visakhapatnam, and the Seth G. S. Medical College, Bombay, are shown in Table V.

TABLE V.

Showing total number of deaths from coronary heart disease on autopsy.

Name of Hospital	Years	Total No. of post-mortems	Total No. of deaths from cardiovascular disease	Total No. of deaths from coronary heart disease
Andhra Medical College, Visakhapatnam ...	1926-61	3300	430	1
Medical College, Calcutta, West Bengal ...	1945-61	2165	206	22
Seth G. S. Medical College, Bombay ...	1946-60	8317	513	217

In the Calcutta series there is an incidence of 10·7% of coronary heart disease amongst the cardiac autopsies and 1·02% amongst the total autopsies. The figures of the Andhra Medical College give the incidence of coronary heart disease as 0·23% amongst the cardiac autopsies and 0·03% amongst the total autopsies. In Bombay, however, the incidence of coronary heart disease is 42·3% amongst the cardiac autopsies and 2·6% amongst the total autopsies.

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It may be pointed out here that the autopsy incidence of coronary heart disease, either amongst the total autopsies or amongst the cardiac autopsies is not likely to be a true index of its clinical incidence. It is certain that many more cases are diagnosed correctly during life and they never come to the postmortem room. A careful scrutiny of the results obtained by the various methods of study so far adopted by the workers in India, shows that in North West India (Amritsar) the incidence is as high as 23%. It is interesting to note that the mortality from coronary heart disease amongst the cardiac deaths in Amritsar is 23·2% (vide Table II). In Eastern India (Calcutta), Western India (Bombay), South India (Madras), Central India (Nagpur) and Northern India (Delhi and Lucknow) the incidence is 10 to 14·4%. In the Himalayan Hills (Simla) and in certain areas of South India (Guntur and Mysore) the incidence is between 5 to 6%. In the South Eastern region (Visakhapatnam) it is extremely low. The reported incidence of 10·2% in Lucknow in 1953 does not appear to reflect the correct position today, because the percentage of mortality from coronary heart disease amongst the cardiac deaths during the period 1958-60 is 23·3 (vide Table II).

Further studies with facilities for long term follow-up are therefore needed in communities including individuals, above 40 years, of high income group (monthly income above Rs. 1000·00) and middle income group (monthly income between Rs. 500·00 to Rs. 1000·00) and of different occupations with varying grades of physical activity.

Age incidence of coronary heart disease.—The author (Banerjea, 1958) has reported in a series of 108 cases, the maximum incidence of 40·7% in the age groups 51—60 years, 28·7% in the age group 41—50 years in contrast to Vakil's 35·6% in the same decade (vide Table VI).

TABLE VI.

Showing the age incidence of coronary heart disease.

Age groups in years	No. of cases	Percentage	
31—40	7	6·5	
41—50	31	28·7	
51—60	44	40·7	90·7
61—70	23	·21·3	
71—80	3	2·8	
	108		

White (1951) in a recent series of 1346 cases of clinical coronary heart disease reports the age incidence as follows :

TABLE VII.

Showing age incidence of clinical coronary heart disease (White, 1951)

Age group in years	Total 1346 cases		
		Percentage	
Under 40		3·8	
40 — 50		12·3	
50 — 60		26·5	
60 — 70		33·1	83·9
Over 70		24·3	

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A comparison of the two tables shows that 35·2% of the cases in Banerjea's series occur in the age group 30—50 years whereas only 16·1% occur in the same age group in White's series ; the maximum incidence 40·7% is seen a decade earlier in the former series than that of 33·1% in the latter series ; moreover in the former series 90·7% of the cases are seen in the age group 40—70 years as compared to 71·9% of the latter series in the same age group.

Sex incidence : There is a marked preponderance of males in coronary heart disease. The male to female ratio varies widely. Vakil reports a ratio of 2·9 : 1, Samani about 5 : 1, Banerjea (1958) (14 : 1, Glendy et al. (1937) give a ratio of 24 : 1 under the age of 40 years ; Hedley (1939) a ratio of 8 : 1 under the age of 50 years, Banerjea (1961) in a recent series of 129 hospital cases of clinical coronary heart disease reports a male to female ratio of 5·6 : 1.

In the age group 60—70 years, Gordon et al (1939) give a ratio of about 3 : 1 in favour of males, whereas Banerjea (1961) gives a ratio of 2·5 : 1 in the same age group.

Occupation and socio-economic status : There is a belief that coronary heart disease has a high incidence in professional men. This is not unfounded. Ryle and Russell (1949) have, from their studies on standardised mortality ratio (S.M.R.), shown that physicians and surgeons had the highest S.M.R. and then in a descending order big businessmen, lawyers and clergymen. Agricultural labourers and miners suffered very much less from this disease. Morris et al (1952) have recently shown that general medical practitioners suffer from coronary heart disease about twice more frequently than the consultants. Banerjea (1958) reports that 77·4% of the cases of coronary heart disease occur amongst the high and middle socio-economic group consisting of lawyers, businessmen, engineers, doctors, and professors. According to him doctors are not predominantly affected.

Pathogenesis

The underlying basic lesion of coronary heart disease is coronary atherosclerosis in the vast majority of cases. It must however, be emphasized that coronary atherosclerosis may be present in an extensive degree, without any reduction of blood supply to the myocardium and any evidence of coronary heart disease. When coronary atherosclerosis is of sufficient degree to cause narrowing or occlusion involving more than 70 per cent of the lumen of a major coronary vessel and thereby interfering with adequate blood supply to the myocardium during periods of increased demand well defined clinical syndromes of coronary heart disease appear, comprising (1) angina pectoris, (2) coronary insufficiency and (3) myocardial infarction. 77·3% of the young soldiers killed in the Korean war with an average age of 22 years, showed gross evidence of coronary atherosclerosis but only 10% showed advanced disease (Engelberg et al, 1956). For a clear understanding of the natural history of coronary heart disease, not only the factors responsible for coronary atherosclerosis but also the factors determining the development of clinical coronary heart disease must be considered. The various etiologic factors that have been suspected to play a role in the pathogenesis may be classified as follows (Olson, 1960).

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1. Environmental factors :

   (a) Occupation
   (b) Exercise
   (c) Stress
   (d) Culture
   (e) Climate
   (f) Diet
   (g) Drugs.

2. Host Factors :

   (a) Age
   (b) Liver function
   (c) Arterial reactivity
   (d) Haemodynamic status
   (e) Endocrine status
   (f) Psychic state.

Occupation and exercise—The role of occupation in the incidence of coronary heart disease has already been discussed. Morris et al (1953) have observed that occupations associated with lack of physical exercise predispose to coronary heart disease and cite a greater incidence among bus drivers, executive officers, telephonists and post office clerks than among the conductors on double decker buses and postmen. The exact role of physical activity is not precisely known. It may promote the collateral coronary circulation. Mann et al (1955) have shown that physical activity prevents the rise of blood cholesterol after the ingestion of an increased quantity of saturated fat.

Stress—It is often thought that the stress and strain of modern life associated with competition, hurry and scurry are important contributing factors. Rosenman and Friedman (1957) found high serum cholesterol and shortening of blood clotting time during the period of maximum stress in 42 volunteer male accountants. It is not unlikely that the changes in blood cholesterol and blood clotting time were caused by ingestion of large amounts of saturated fats in the form of snacks usually taken by such accountants during maximum work periods. Further the stress and strain of the war years in England and Norway during the World War II did not show any increase of mortality from coronary heart disease. On the other hand, Malmros (1957) reported a sharp decline in mortality from coronary heart disease in Norway during that period. It appears therefore that stress is not an important factor in the etiology of coronary heart disease.

Climate—From a comparative study of the incidence of coronary heart disease in the adjoining States of India such as Madras and Andhra Pradesh (Guntur and Visakhapatnam), it is seen that the incidence is much higher in the former than in the latter (vide Tables I & II) though the climate is almost the same in the two States. A comparison of the incidence data in Delhi and Amritsar also shows that climate is not a determining factor.

Tobacco—Smoking of cigarettes has been considered to be one of the etiologic factors of coronary heart disease. Hammond and Horn (1958) followed up nearly 2,00,000 men for three years and a half and compared death rates according to their smoking habits at the beginning of the survey. There were 7,316 deaths among cigarette smokers, whereas only

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4,651 deaths would have occurred if the subjects had been exposed to the same death rates as non-smokers. Over half of the excess of 2665 deaths was due to coronary heart disease. Banerjea (1958) found, from an enquiry of 73 patients in his series of 108 with coronary heart disease, that 64·4% were either moderate or heavy smokers.

Diet and Coronary Heart Disease

In recent years most workers are agreed that obesity, resulting from consumption of a high caloric diet more than the body needs, is an important factor in the etiology of coronary heart disease. Such high caloric diets are likely to contain animal fat 40-45% of the total caloric intake (Page et al, 1957). Life Insurance data (Dublin et al, 1951) indicate that the mortality from coronary heart disease in obese persons is 40% higher than that among standard risks. Gertler et al (1950) did not find obesity to be more common in young men with coronary heart disease than among other men of the same age and social status. Banerjea (1958) studied the body weight in 42 cases of coronary heart disease and found that 17 (40·5%) had average weight, 18 (42·8%) had overweight and 7 (16·7%) had underweight. Thus obesity did not appear to play any significant role in his series. The real problem is, therefore, not obesity but the dietary intake of fat to the extent of 40-45% of the total calories. Obesity alone (Keys, 1956) cannot account for the marked differences in the incidence of coronary heart disease in the various countries. Even if obesity were eliminated in the U.S.A., coronary heart disease would still be its foremost public health problem.

Total fat in the Diet—Keys et al (1953) have the piority in pointing out a close relationship between total fat intake and death rate from coronary heart disease. Populations with an intake of fat of above 40% or more of the total calories have high death rates from the disease, whereas those with fat intake below 20% of the total calories have low death rates.

This concept was opposed by the National Dairy Council (1956), Yerushalmy and Hilleboe (1957), Page et al (1957), Yudkin (1957) and Mann (1957) on the ground of low mortality, about one third of that in the U.S.A., found in Norway, Sweden and Denmark, although fat percentage of the total calories in the diet was almost identical with that in the U.S.A. or the U.K. The opponents failed to take into consideration the quality of fats consumed by the former countries. Their intake of fat comprised large amounts of fish and marine oils and also unhydrogenated vegetable fats.

Quality of fats in the diet—There are mainly two types of fat (1) Saturated (as in milk, butter, eggs and meat) ; (2) Unsaturated (as in fish, grains, nuts and vegetables). The modern commercial process of hydrogenation brings about certain chemical changes in such oils, as cotton seed or soya bean which transform them into solid fats at room temperature with the reduction of linoleic acid content to 3-8% from the original 50% approximately (National Research Council, 1958). Further, certain isomers of the essential fatty acids formed during hydrogenation can not be utilised as substitutes for their natural precursors and in fact they act as metabolic antagonists to them (Holman, 1951).

Disorder of Lipid Metabolism and Coronary Heart Disease

Various observers such as Kinsell et al (1952), Keys (1956), Bronte-Stewart et al (1955), Jolliffe (1957), have shown by population studies that diets containing large amounts of highly saturated fats (milk, meat, egg,

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butter, coconut oil) raise the levels of serum cholesterol and betalipoproteins. On the other hand, substitution or inclusion in the diets, of marine and vegetable oils, naturally rich in linoleic or other poly-unsaturated fatty acids, causes a fall in the serum cholesterol which has been maintained for as long as six months on such diets (Bronte-Stewart et al, 1956). It has also been shown, that when these vegetable oils or their poly-unsaturated fatty acids are hydrogenated, the cholesterol-lowering effects disappear.

It is, however, not yet definitely known whether the excess of saturated fats alone, or the lack of poly-unsaturated fatty acids or a disproportion between both factors is responsible for the alteration of the blood lipid pattern. Ahrens et al (1957) incriminate the lack of poly-unsaturated fatty acids, while Kinsell (1958) and Sinclair (1956) attribute the responsibility to a deficiency of the essential poly-unsaturated fatty acids and Keys et al (1958) hold the disproportion in the ratio of saturated to unsaturated fatty acids in diet as responsible. The anomaly of high fat diet with low death rate from coronary heart disease in Norway, Denmark and Sweden has been clearly explained by Morris (1956) and Jolliffe et al (1960) on the basis of large amounts of fish, marine and vegetable oils rich in poly-unsaturated fatty acids being used in the dietary of the people of those countries.

From population studies Keys points out that coronary heart disease is common in any population when middle aged men have an average serum cholesterol of 220 mgm% or over e.g. the U.S.A., U.K., West Germany, Sweden, Netherlands, Madrid (Upper class men) and Cape Town (Europeans) in South Africa. In populations where the middle aged men have average cholesterol lower than 200 mgm%, the incidence of coronary heart disease is low as for example, amongst the men in Southern Italy, Sardinia, lower class men in Madrid, Bantus in Cape Town, Guatemalan Indians, Nigerians, Yemenite Jews. Population studies support the existence of a close correlation between the amount of saturated fat in the diet, serum betalipoprotein and coronary heart disease in middle age. High intake of, natural or hydrogenated, saturated fats, or an inadequate intake of linoleic acid, essential for adults (Kinsell et al, 1958) or of other poly-unsaturated fatty acids raises the total serum cholesterol.

Roine et al (1958) have shown in Finland that a diet with 35% of calories from fat, mostly saturated, was associated with a high average serum cholesterol (260 mgm%) and a high incidence of, and mortality from coronary heart disease. Gupta et al (1958) in New Delhi, found significantly higher serum cholesterol levels in patients of coronary artery disease in comparison with normal urban Indians matched for age and occupation. Padmavati et al (1959) have also shown high serum cholesterol level in middle aged men above 40 years, of the high socio-economic groups in Delhi, living on a dietary with about 32·8% of calories from fat (mainly saturated). It must however be emphasized that hypercholesterolaemia and coronary heart disease are not necessarily causally related (Ahrens et al, 1957). Wilkinson et al (1948) observed that there was no more increased incidence of coronary heart disease amongst the hypercholesterolaemic members of a family than in those with normal serum cholesterol.

In this context, the observations of Barr (1953), Russ et al (1955), Oliver and Boyd (1956) are pertinent. They emphasize in atherosclerosis on the increase of serum betalipoproteins in spite of normal levels of total serum cholesterol and normal cholesterol phospholipid ratio. Gofman et al

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(1952) went a step further in pointing out that serum lipoprotein of S_f12—20 and S_f35—100 were atherogenic. They observed a closer correlation between lipoproteins of S 35—100 and obesity than between those of S_f12—20 and obesity. Prolonged low fat diet gradually reduced the concentration of abnormal blood lipids.

The abnormal blood lipid pattern in coronary heart disease is the same as in the diseases associated with advanced atherosclerosis such as diabetes mellitus, myxoedema, nephrosis, xanthomatosis and familial hypercholesterolaemia (Gofman et al, 1952 ; Katz and Stamler, 1953).

Experimental atherosclerosis—It was first produced by Anitschkow (1913) by feeding rabbits on diet rich in cholesterol. Since then numerous experimental animals have been used. It was soon found that many animals like man (mouse, rat, dog and cat) do not respond by hypercholesterolaemia to feeding with diet rich in cholesterol, unless additional measures such as thyroid ablation (chemical or surgical), or cholic acid feeding are adopted. Cholic acid feeding promotes the absorption of cholesterol and inhibits the formation of cholic acid from cholesterol. Once marked hypercholesterolaemia is produced, atherosclerosis develops in all the species. Hartroft (1957) has produced lesions of myocardial infarction in rats with severe hypercholesterolaemia.

Epidemiologic and clinical studies and animal experimentation strongly support the view that hypercholesterolaemia and hyperbetalipoproteinaemia resulting from high intake of saturated fats or inadequate intake of poly-unsaturated fatty acids are closely associated with atherosclerosis. As a result of this altered blood lipid pattern, cholesterol and betalipoprotein are imbibed into the intimal layers and lead to the atheromatous lesion (Virchow, 1856). A high proportion of cholesterol has been found in these lesions (Windaus, 1910). According to Wilens (1951) intimal deposition of cholesterol is favoured by the increased concentration of betalipoproteins more adapted to penetrate the intima under increased filtration pressure as in hypertension. Wilen's view (1947) that atherosclerosis is twice as frequent in hypertension as in normotension can not be accepted as far as coronary atherosclerosis and coronary heart disease are concerned. Banerjea (1958) showed from a careful observation of 87 cases of coronary heart disease that the blood pressure was in the normal range in 51·7%, the upper limit of normal range being taken as 140/90 mm. of Hg. Moon and Rinehart (1952) have emphasized on some alteration in the ground substance of the intima that precedes the atherosclerotic lesion due to deposition of cholesterol and betalipoproteins.

So long discussion has been focussed on the atherogenic aspects of diet with high saturated fats or inadequate poly-unsaturated fatty acids. But the role of dietary factors other than fats has not yet been considered. It may be pointed out that Keys (1957) did not find any significant changes in blood lipids by altering the quantity of protein from 11 to 20% of the total calories, the calories from fat and its quality being kept constant. Olson et al (1958) however reduced the protein quantity gradually in 9 human subjects of middle age from 120 gm. daily to 25 gm. daily (fat calories and its quality being kept constant) and showed a fall in serum cholesterol by 15% within 2 weeks. Furman et al (1960) have reported a marked fall of serum cholesterol and betalipoproteins by isocaloric substitutions of carbohydrates from the whole quantity of protein in the diet of adult men, containing 40% of the calories from corn oil

It is well recognised that in Kwashiorkor, severe protein malnutrition in infants and children, there is a marked fall of serum cholesterol and the alpha and betalipoproteins (Scrimshaw et al, 1956 ; Frenk et al, 1958).

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The hypocholesterolaemia responds promptly to feeding with fat free milk protein. It appears, therefore, that protein is necessary for the formation of betalipoproteins. Nevertheless it does not indicate that protein plays any significant role in atherogenesis.

High carbohydrate diets raise the serum triglycerides and betalipoproteins S_f 12—100 ; the lipoprotein concentration is affected by diversion of the metabolites of cholesterol from the entero-hepatic circulation by the oxidative action of the intestinal bacterial flora (Portman et al., 1959). There is, as yet, no definite evidence that vitamins and minerals in the diets of various populations play any significant role in influencing the concentrations of serum lipoproteins. A nutritional survey of the Armed forces in the Phillipines failed to show any relationship between specific vitamin deficiency and serum cholesterol.

Pyridoxine deficiency has been suggested to operate through a disorder of fat metabolism due to failure of linoleic acid to be converted into arachidonic acid. Altschul et al (1955) have reported on the pharmacologic effects of large doses of niacin, 1 to 6 gm. daily in causing a significant fall in the serum cholesterol levels in man with marked excretion of nicotinuric acid. This effect is probably the result of diversion of the Co-enzyme A from cholesterol biosynthesis to Co-A dependent glycine conjugation of nicotinic acid.

Recently, Gresham and Howard (1961) have drawn attention to the thrombogenic factors in the diet. Thomas et al (1959) found that feeding experiments with butter combined with hypercholesterolaemic agents produced thrombotic lesions often in the cardiac chambers, aorta, coronary and other arteries and renal veins without any atherosclerotic lesion. Hill et al (1960) had electrocardiographic and histological evidence of myocardial infarction in some animals fed in that way. The experiments support the view that thrombosis may occur independently of atherosclerosis, though they are associated together because of a common origin. It was Rokitansky (1852) who suggested that atherosclerosis was the result of organisation of a thrombus incorporated into the intima with vascularisation.

Duguid (1946) revived the hypothesis with special reference to coronary atherosclerosis. Macdonald et al (1959) found increased stickiness of blood platelets and shortening of blood clotting time in patients of coronary heart disease, though Merskey et al (1960) did not find any significant differences from normal. Davidson et al (1961) found shortening of blood clotting time as measured by the one stage plasma prothrombin time and the whole blood silicone clotting time in rats fed with thrombogenic diet. Gresham and Howard (1961) suggest from the above experimental data that increased coagulability of the blood plays an important role in the increased incidence of coronary heart disease and that atherosclerosis is not the result of a relative deficiency of essential fatty acids.

Dietary fats and decreased fibrinolytic activity : It is known that certain dietary fats after ingestion decrease the fibrinolytic activity. It is probable that decreased fibrinolysis may be a determining factor in the production of intravascular clotting and coronary heart disease with or without associated marked atherosclerotic changes in the coronary arteries.

Endocrine factors

Sex hormones—Young women rarely suffer from coronary heart disease unless they have diabetes mellitus or hypertension. Normally

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they have relatively lower level of serum betalipoprotein and more of alpha lipoprotein, as compared to young men of the same age groups. But this difference is not obvious after the menopause (Russ et al, 1955). The lipoproteins of the S_f 10—100 classes which are atherogenic in nature, are found in lower concentration in young women than in the young men (Jones et al, 1951). Postmortem observations (Wuest et al, 1953) show a greater incidence of coronary atherosclerosis of greater severity in bilaterally oophorectomised women than in control females. Compared to the men of the same age group the incidence and severity of coronary atherosclerosis were almost the same. It was further observed that the incidence and severity of atherosclerosis were much less in men treated with oestrogens for prostatic carcinoma that in the controls (Rivin et al, 1954). Oestrogen administration can inhibit the cholesterol-induced atherosclerosis in cockerels (Katz et al, 1953) and it can also reverse the same process. Serum cholesterol and the cholesterol phospholipid ratio are reduced by administration of oestrogens to premenopausal and postmenopausal women. Barr et al. (1955) have demonstrated a significant fall in total serum cholesterol, betalipoprotein and cholesterol phospholipid ratio in survivors of acute myocardial infarction by administration of ethinyl oestradiol. These effects were diminished or nullified by the simultaneous use of androgens to counteract the unpleasant side effects of oestrogen therapy. Search is being made for synthetic oestrogen that will have hypocholesterolaemic but less oestrogenic effect. One such agent is MER 29, triparanol which reduces serum cholesterol and has no oestrogenic effect (Blohm et al., 1959). It interferes with the late phases of cholesterol biosynthesis and increases in the liver and blood, desmosterol—a precursor of cholesterol (Avigan et al, 1960). Testosterone has no effect on total serum cholesterol but causes an increase in the betalipoprotein with reduction of alphalipoprotein. Russ et al (1955) have shown that androgens completely abolish the action of oestrogens on serum cholesterol and lipoprotein in man without influencing the feminizing effect of the oestrogens. Hellman et al (1959) have, however, shown that the administration of etiocholanalone and androsterone produces a distinct fall in the serum cholesterol.

Thyroid gland—It has a great influence on cholesterol metabolism. In myxoedema, there is a rise of serum cholesterol, cholesterol phospholipid ratio (Peters et al, 1943) and of betalipoproteins of S_f O—12 class chiefly and also of S_f 12—400 (Malmros et al, 1953 ; Gofman et al., 1954). These abnormalities may be reversed by small doses (15 to 30 mgm) of desiccated thyroid (Kurland et al, 1954-55). In animals, hypothyroidism, however produced, by surgical removal (Gilligan et al, 1934), use of radioactive iodine (Blumgart et al, 1953) or use of thiourca derivatives (Rosenman et al, 1957), is associated with hypercholesterolaemia. The rise of serum cholesterol in myxoedema is due to greater diminution of bile acid excretion than the diminution of cholesterol synthesis. There is a good deal of controversy over the question whether myxoedema predisposes to atherosclerosis. Blumgart et al, (1935) did not find any significant coronary atherosclerosis, at autopsy of accidental deaths 1 to 13 years after therapeutic total thyroidectomy, in patients of rheumatic heart disease with severe congestive failure associated with consequent hypercholesterolaemia. From animal experiments it appears that cholesterol feeding accompanied by thiourea-induced hypothyroidism results in marked hypercholesterolaemia which, if maintained for a long period, will produce atherosclerosis in most species. Recently attempts are being made to bring about a persistent reduction of serum cholesterol and influence the

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natural history of atherosclerosis in patients with coronary artery disease, euthyroid or hypothyroid, by newer derivatives of thyroxine without increasing cardiac metabolism, such as d-thyroxine and d-tri-iodothyronine (Bauer et al, 1959).

Adrenal cortex. In clinical conditions associated with hyperactivity of the adrenal cortex (Cushing's syndrome) there is hypercholesterolaemia and in adrenocortial insufficiency there is hypocholesterolaemia (Heinbecker, 1950). In adrenalectomised dogs kept alive by the administration of desoxycorticosterone acetate (DOCA) there is a progressive fall in serum cholesterol and phospholipids which may rapidly be restored to normal levels by the administration of cortisone after the withdrawal of DOCA (Di Luzio et al, 1954). On the other hand, Conn et al (1949) and Oliver et al (1956) have reported a fall in serum cholesterol and betalipoproteins in patients of coronary artery disease during short term therapy with corticotrophin or cortisone acetate. But the observations of Adlersberg et al (1951) do not support those of the previous workers. The effects of corticotrophin and cortisone administration are not consistent. Bloom and Pierce (1952) found a decrease in serum cholesterol after short time corticotrophin therapy, whereas long term cortisone therapy did not show any change in the serum cholesterol or lipoprotein of S_f 10—20 class.

Adrenal cortex and stress: Some studies have been made on the relationship of adrenal cortex to stress. Surgery, infection and starvation in man and animal cause a decrease in serum cholesterol (Kyle et al, 1952). Heinbecker et al., (1950) have suggested that advanced atherosclerosis may occur early in men with hyperadrenocorticism but it is difficult to assess the relative role of the associated conditions such as diabetes, hypertension and the blood lipids. Uhley et al (1959) has shown that stress may promote the development of athrosclerosis in rats.

Adrenal medulla—The hypercholesterolaemia of stress is due to increased secretion of both cortical and medullary hormones. Havel et al. (1959), Shafrir et al. (1959) have demonstrated that norepinephrine and epinephrine injections in man and in dogs produce an increase of blood fatty acids and lipoproteins.

Pituitary gland—The role of pituitary hormones on lipid metabolism and atherosclerosis is unknown. The pituitary generally acts through its target organs, adrenal cortex and thyroid. Recently, Seifter et al. (1956) and Rudman (1960) have suggested the existence of a separate fat mobilizing hormone that brings the fat into the circulation from its depots. Miller et al. (1959) have produced in the white female rat resistant to experimental atherosclerosis, advanced atherosclerosis with coronary involvement and infarction by the administration of corticotrophin.

Heredity—The consideration of heredity has been postponed to the concluding stage of this discussion on the pathogenesis of coronary heart disease, not because its influence is much less known than that of the other factors, but because its influence, if any, can not be controlled. It is well known that coronary heart disease may occur in several members of the same family. Cassidy (1946) reported familial incidence in 50% of his 1000 cases ; Yater et al (1948) found a familial incidence of coronary heart disease four times as common in their 744 young patients under 40 years as in normal controls. Thomas et al (1959) also observed that clinical coronary heart disease was about four times more frequent among the siblings of the persons with coronary heart disease than among those of the persons without it. It has been suggested that an inferior quality of vessel is inherited and that it is too weak to withstand the mechanical strain imposed by the circulating blood volume and the intravascular

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pressure. The arterial wall gets easily damaged, particularly at the sites of bifurcation or near the origin of its branches and paves the way to deposition of blood lipids in the intima and production of atherosclerosis. There is, however, no adequate experimental evidence to support the concept of inherited inferiority of the arterial wall.

From a review of all the foregoing data of epidemiologic studies, clinical investigations in human subjects and laboratory investigations in experimental animals fed on purified diets, it appears that coronary heart disease is caused by multiple factors. The consensus is that high intake of saturated fat or inadequate intake of poly-unsaturated fatty acids in diet raises the serum cholesterol and betalipoproteins. It is probable, though not acceptable to all workers, that this altered blood lipid pattern leads to coronary atherosclerosis and coronary heart disease. It is supported on experimental basis that saturated dietary fats, or poly-unsaturated fatty acid deficiency may cause increased blood coagulability and decreased fibrinolysis leading to intravascular clotting. It is possible that these two factors, increased blood coagulability and decreased fibrinolysis, may determine the development of coronary heart disease in individuals with the same degree of coronary atherosclerosis.

It is also not unlikely that coronary atherosclerosis and intravascular clotting may both play an important role in the natural history of coronary heart disease.

Prevention of Coronary Heart disease

An assessment of the relative importance of the various factors ; such as age, sex, heredity, endocrine status, culture, climate, occupation, physical activity, stress, tobacco habit, and diet, in the etiology of coronary heart disease, is essential for the planning of a public health programme for the prevention and control of coronary heart disease. While age, sex, heredity and climate cannot be controlled, other factors can to a considerable extent be modified with the help and co-operation of the public.

The dietary approach should be the primary step in this preventive campaign. Middle aged people of the high socio-economic group and the upper middle class should guard against obesity. The fat content of the diet is not to exceed 25% of the total calories ; about 10% of these fat-calories should be derived from poly-unsaturated fatty acids as in fish, marine oil, natural vegetable oil or corn oil. Saturated fat from milk, butter, meat fat and egg is to be excluded as far as possible from the diet. Lean meat, fish, vegetable protein, skimmed milk and fat-free cheese may be used to maintain adequate protein requirements. Physical exercise in the form of walking one or two miles a day is to be taken regularly. Worries and mental stress are to be avoided as far as practicable. Use of tobacco in all forms has to be stopped or reduced to the minimum.

Persons with a family history of cerebrovascular accidents, hypertension, coronary heart disease and diabetes mellitus or those who have a high blood cholesterol with or without hypertension and diabetes mellitus, should all the more follow the above instructions. Attempts are recently being made to maintain serum cholesterol levels within the normal range by the administration of MER 29—triparanol, but it is not a practical proposition as a public health programme.

The programme for the prevention and control of coronary heart disease mentioned above, may appear formidable to many but it is the best that the present knowledge of coronary heart disease can offer to the

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public. It is hoped that the nutritional experts would suggest suitable dietary formulae along the above mentioned lines that would be acceptable, palatable and at the same time balanced with regard to the various essential constituents of food.

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SECTION OF AGRICULTURAL SCIENCES

President :—Prof. P. K. Sen, M.Sc. (Cal.), Ph.D. (Lond.), D.I.C.

PRESIDENTIAL ADDRESS

WHY AGRICULTURAL SCIENTISTS HAVE FAILED TO MAKE THEIR IMPACT ON FOOD PRODUCTION AND NATIONAL DEVELOPMENT

I am thankful to the members of the Agricultural Sciences Committee of the Indian Science Congress Association for electing me President and thus giving me the opportunity of placing before you the problem of food production, as I see it.

The history of man is largely the chronicle of his quest for food. Inspite of spectacular advances in science, the contemporary man still remains subdued by hunger over the greater part of the world. Scientists do believe, however, that if only their existing knowledge were applied, taking no account of any future discoveries, there could be an enormous increase in food production more than sufficient for the hungry people of the world for a good many years to come. But there exist serious social and economic impediments in the way of putting the knowledge to work on a full scale.

In India food shortage is reported to be only about 15 to 20 p.c. And, yet, it is enough to degrade us and menace our efforts towards progress. Our agriculture has largely remained primitive and its outstanding problem is low yield, almost the lowest in the world. Agricultural scientists of India have shown how production can be increased atleast upto 200% (i) by supplying water to the crops to sustain them in dry seasons, (ii) by giving them nourishment in the form of fertilizers and manuers, (iii) by introducing better crops or varieties and animals or breeds, and (iv) by employing modern methods of cultivation. But, their findings have hardly permeated beyond the fencings of their experimental farms, because the agriculturists, comprising 60 to 80 per cent of the people, are poor and backward. The existing conditions of farming attract no enterprise. Elites have no interest in rural life or agriculture. Even sciences of agriculture fail to attract the cream of our intelligentsia. We have generally to contend with very mediocre students in our agricultural institutions while brighter ones go in for engineering or medicine or some other more remunerative lines. The weakness of the agricultural front is also evident in our administration. Agricultural service offers little scope for the meritorious, and it enjoys, perhaps, the least political backing.

The industrial revolution in England set the pace for gradual decline in rural sector and degeneration of the agricultural situation of India. The decline in complementary village crafts created a vacuum, which unlike in Britain could not be filled up by industries as they were then not developed in this country. The result was that more and more people

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had to fall back upon agriculture making it overcrowded. The progressive elements in the society drifted towards the cities in search of a better standard of living through services in British trading establishments and in offices of administration. Effectively enterprising leadership having thus deserted the countryside, the rural economy fell into chaos with only the absentee landlords, money lenders and middlemen riding roughshod over the agricultural population of the country. Indebtedness of the peasantry, famine, epidemics, neglect of flood control, soil conservation and irrigation devices and crumbling organisation of village institutions leading to overall deterioration in the agricultural output became the order of the day. Agriculture and rural life thus became synonymous with poverty and backwardness and yet ironically enough the country as a whole continued to depend very largely on its rural resources. Thus, for all practical purposes, the rural sector was reduced to the status of a mere colony of the urban sector.

With the whole countryside remaining undeveloped and the large majority of the people poor and backward on one side and with a mighty imperial power dominating the country on the other, the progressive genius of India soon came to realize that social integration and rural reconstruction were fundamental for the country's survival and that agriculture must be the basis of its economic development. This brought in its wake fervent activities towards gaining political freedom on the one hand and an arduous upheaval for social reforms on the other aimed primarily at effecting a confluence between the diverging ways of rural and urban life in the country.

With independence the country had, therefore, to take up seriously the task of rural reconstruction and agricultural development. Certain laws have been enacted with the view to abolishing absentee landlordism. Expansion of credit facilities, attempts at maintaining a remunerative price-level for the main crops and organising cooperative marketing are certainly steps towards putting an end to exploitation by money lenders and middlemen. Some of the material aspects of farming are also being attended to. For example, some large and small irrigation schemes have been taken up, fertilizer factories are being established, more seed farms and expansion of agricultural research and extension services have been brought into operation. Educational facilities and health services are also being extended in rural areas. Still, there remains a glaring lacuna in the whole endeavour in the sense that there has been no incentive that will attract the enterprising progressive elements to agriculture and rural life. Even village youths and sons of farmers, who get the opportunity of education, consider it below their dignity as growing elites to pursue this nonremunerative career of farming and hardly ever hide their discontentment with rural life. Those people who come to towns in services do not like to go back to their villages on retirement. Thus, rural India has continued to remain backward culturally and economically.

The onus of agricultural development and rural reconstruction thus remains almost entirely the charge of government services and subsidy. It is needless to dwell upon the limitations of the services which is evident from their characteristic bureaucratic nature. And subsidies distributed to unenterprising poor mass of cultivators often prove wasteful. The whole situation has become further vitiated due to the fact that the country does not possess the resources of big industries to develop and maintain agriculture entirely on subsidies. And while there is food shortage it is difficult to conceive of any progress with industrial and other developmental projects.

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In view of this basic reason of the country's proverty and in view of the responsibility of democracy, it is essential to create economic incentive for progressive elements, especially from among those coming from rural areas to take up farming and thus bring into the profession the benefits of science, technology, business management and social understanding. The example of small and medium size proprietor farming and service cooperatives, as in Japan, Holland, Denmark and in a number of other countries, should be more applicable to India than large scale cooperative or collective organisations. Proprietor farming would offer the fullest scope for enterprise to play its role in production efforts while service cooperatives for marketing etc. should develop readily due to their obvious advantages. An elite leadership to this effect is fundamental but an idealistic approach by itself is not enough. Economic incentives are also necessary.

Experiments on intensive cultural practices on small farms carried out during the last five years, in cultivators' holdings, in certain areas of Burdwan district in West Bengal under the auspices of the Department of Agriculture, Calcutta University with the financial support of the Indian Council of Agricultural Research and cooperation of the Directorate of Agriculture, West Bengal have shown that, at current prices, on an average, a 3-acre holding could earn a net income of Rs. 100 per month and a 5-acre holding a net income of Rs. 200 p.m. In these studies the only additional input above the resources of the cultivators themselves was of the value of Rs. 75 per acre per annum comprising cost of fertilizers, seeds, labour for irrigation and interculture, and for plant protection measures. The amount available was by no means enough and although the areas were selected within the Damodar Valley Project belt, irrigation facilities were not yet fully available as construction of the canals and channels were yet to be completed. About two-third of the areas under each type of holding, consisting of paddy land, had a single crop, and the remaining area, consisting of high land, had a *Kharif* and a *Rabi* crop. With irrigation and protection against stray grazing, double cropping would be possible over the whole area of the holdings. Also, there exists further scope for application of fertilizers and making improvements in cultural practices that would give a far greater return from the land.

It would, therefore, not be unreasonable to expect average incomes between Rs. 300 and Rs. 1500 or more p.m. from holdings of sizes ranging between 5 and 25 acres. It may be worth mentioning here that at least 30 p.c. of the agricultural holdings of India fall between these sizes. There is no reason, therefore, why education and enterprise should find no place in farming. Educated youths who lack no enterprise in their pursuit of an employment in which even graduates can hardly expect an earning of Rs. 200 a month, should find agriculture to be a worthy way of fulfilment and even men of talents would be attracted to agriculture once its economic basis is established. Cultivators with very meagre holdings may also look forward to more decent incomes once enterprising farms consolidated into economic sizes through integration of their small bits of lands are materialized as an essential phase in the development of agriculture and such small cultivators can find more remunerative employment as skilled workers in these economic farms.

As agriculture develops, industries for the manufacture of fertilizers, implements and machineries and also for meeting the increasing demands for consumer goods would readily spring up, thus opening better vistas of employment for millions. It would not be unrealistic, therefore, to effect a planned diversion of at least half of our agricultural population to industries and services within the next, say, 25 years. Our average farm size by this

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time may be 10-15 acres between the minimum and maximum of 5 and 25-30 acres. This will yield an average income of Rs. 600-1000 p.m. from agriculture as a profession with the minimum and maximum earnings ranging between Rs. 200-300 and Rs. 1500-2000 p.m. Thus, we may well expect an average proprietor-farmer-manager-worker of India to be a man of education and enterprise, holding the foundation of the socialistic pattern of the society which we cherish as our ideal, creating the desired impact on the social and political economy of the country and maintaining a progressive standard of agriculture and its parity with all the other sectors of national life.

It is significant to note in this context that the Government have rightly accepted 5 acres as the minimum size of an economic holding and a ceiling of 25 to 30 acres. It is also true that its community development programme stresses the need to develop the cultural and economic status of the rural people. And, yet, the measures taken so far towards the realization of these objectives through the national development plans have lacked the requisite emphasis on the most vital point of creating adequate economic incentives for enterprising leadership in farming and rural life.

It would appear, therefore, that there has not yet been a scientific appreciation of the limiting effects of the social and economic conditions on "enterprise" which is one of the essential factors of production, be it agricultural or otherwise. Our plan programmes appear yet to remain largely dominated by the colonial attitude of our urban sector towards the rural sector. Thus agriculture, which must provide the economic foundation of the country continues to be looked upon as a field of welfare work rather than that of economic development. Whatever enterprise there is in the country remains restricted to the urban sector and in unproductive services, more and more weakening our economy and political stability. It is perhaps significant in this context for our agricultural scientists to interpret what prompted Mahatma Gandhi to suggest shortly after independence that a *Kisan* (farmer) should be the Prime Minister of India.

Our Plan approach needs a revolutionary change inasmuch as agriculture must be given the highest priority. It is time that our Government gathered the courage to take appropriate measure first of all to train the social forces in order to check the continued drift of all initiative and investment to the urban sector and to divert enterprise in sufficient measure to the rural areas, as it has been attempting to train the river currents to control floods and to distribute water to the soils. May it be realised that human investment is fundamental in social progress and economic development, and every bit of our material resources should be scientifically employed to enthuse the human element to increase production, and for that matter Food First.

Thus it is imperative for the present and the next one or more plan periods that all major and minor development schemes and social services programmes must be concentrated towards building up the agricultural foundation of the country.

Flood control, drainage and irrigation, communication and supply of electricity are the basic physical conditions required for our agricultural and rural development. Despite full realization of this fact, adequate and fullsome measures to meet these requirements have yet to be taken. These certainly involve long term investments which only the Government can make and must need the foremost priority in the allocation of national and international resources available for the development of the country. We can not escape the fact that our Governments both in the centre and in the States have so far been largely reluctant to make adequate budget-

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ary provisions for full scale agricultural development in the country. It should not be difficult for the government, to raise the due national share of the finances required for agricultural development. We have one of the lowest rates of taxation in the world (less than 10 p.c. of national income), and we indulge in a great deal of so called prestige expenditures while our people go hungry. Our concept of a socialistic pattern of society must needs be based on a judicious balance both in emphasis and in apportioning the various essential physical and intellectual resources to rural and urban sectors.

Once these basic requirements have been earnestly met, agriculture would not lack in enterprises. Supply of credit and manufacture of fertilizers, chemicals, implements and machinery, for which there can be economic demand only after agriculture begins to develop on an economic basis, would be possible through big and small private industries, and their distribution may also be made through the normal market without the Government having to block much of its funds, in the public sector, on them.

Along with the development of the aforesaid basic physical conditions it would, however, be necessary also to set up econmic farms of various sizes between 5 and 25 acres in the different regions of the country representing varying types of soil and climate, preferably through the collaboration of private enterprise, on the one hand for result demonstration of such enterprises and on the other for collection of basic data for economic planning and marketing control. It is well known that the sort of data which we have at present to rely upon are more guess estimates than facts.

Equally important is the need for a radical reorientation in our outlook towards agricultural education. None of us disputes the fact that the average product of our agricultural colleges and other institutions imparting agricultural education turns out to be an uninspiring unit of the agricultural machinery of the Government. This in turn reflects upon the efficiency of our research and extension activities. Much of it has been due to the absence of enterprise and a progressive outlook of our agriculture. The essential aspect of agricultural education in the country should be practical training in economic farms. In most of the agriculturally advanced countries such practical training is imparted through private farms. Students of an agricultural college have to work as paid apprentices in such commercial farms at least for a year either before their admission or in between their courses of study, in addition to attending practical classes in the college farm. And most agricultural schools are based on living farms in which the students reside and partake in all kinds of operations.

We should similarly provide our agricultural schools with living farms. And as economic farms are established in the country students of agricultural colleges should have the opportunity of working in them as apprentices. Such farm training which should be on an earn and learn basis will help to develop a more objective view of agriculture as an enterprise.

Only with enterprising elites coming to farm life agricultural scientists would find the field and the much needed opportunity for applying their knowledge to practical tests in farm production and thus demonstrate the effectiveness and utility of their researches and new discoveries. And, as already mentioned, an elite leadership in rural life would have its rightful impact on all round national development.

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SECTION OF PHYSIOLOGY

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PRESIDENTIAL ADDRESS

WIDENING FRONTIERS OF NUTRITION RESEARCH

We have assembled at the 49th Session of the Indian Science Congress, and it is a privilege to be with you all, interested in the science of physiology and allied disciplines. At the present stage of our development we need more care for our health and resources as we will have to work for the enhancement of the economy of our country. In such an endeavour the body is to be kept in vigour and should not be liable to physical or mental disability under any condition of food supply and nourishment. It is for this, I desire to touch upon the problem of nutrition, a subject in which we have been taking an active interest for the last two decades or so, but before I begin, I wish to express my deep sense of appreciation for the opportunity you have given me by electing me the President of your section. Let me welcome you all and let me hope that with your co-operation, it will be possible to have a thoughtful discussion on the promotion of physiological sciences in this session that has been arranged in this State of Orissa where several dynasties with different ideologies had met in the ancient past only to be absorbed into a nation of men great in art, architecture and culture.

Human nutrition is perhaps the greatest and most complex scientific and social problem of our time. It is becoming more so because of the formidable rise in population. Each time an accurate census is taken in the world, the population is found to be greater than had been previously existent. The number in India now stands at about 438 millions. Relatively the agricultural production has remained almost stagnant and as such this rate of population growth acts as one of the most severe brakes on the raising of the standard of life and the supply of proper nutrition to the people of the country. The question is whether we may consider the improvement of our nutrition bearing in mind the problem of population explosion, social and demographical condition and century-old cultivation methods without much alterations. Nutrition as the systematic science is just growing but its achievements during the last few decades have been so great and impressive that one can now reasonably venture to predict a much higher level of health by the application of its major principles. While elaborating the present-day trends in nutrition research I would like with your permission to present before you some aspects of investigations upon which we have been engaged for a considerable period.

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Nutritional Needs and Food Supply

Early workers defined our needs in terms of various nutrients present in food materials such as vitamins, minerals, proteins and amino acids, fats and carbohydrates and then turned their attention to means of application. An effective nutritional programme must be based on a knowledge of the nutritional needs of the population in question and of the nutritive value of the food supplies actually or potentially available. Nutritional requirements for the different segments of the population are bound to vary due to various factors as significant differences exist in terms of racial characteristics, environment, endemic diseases, varieties of food crops and others. Dietary studies thus reveal enough differences in food patterns influenced by economic, religious and social conditions. Apart from these considerations food standards are expected to vary depending upon the body size, activity and climatic changes. Further, in assessing the physiological needs for optimum nutrition extensive medical or nutritional surveys are essential. Such surveys should give attention not only to the specific deficiency diseases but also to other pathological conditions and infections which are likely to contribute to malnutrition. The extent of the occurrence of the pathogenic parasites, which are so common in tropical areas and under unsanitary environments, is of special importance. Under these and various other disorders body's needs for various nutrients and the extent of their utilization may be markedly changed and modified.

Dietary deficiency and other abnormalities :

The dietary surveys conducted in various parts of the world have already revealed the nature and extent of deficiency of different essential nutrients in average diets. The peoples of the world who have the greatest or most severe nutritional problems consume diets primarily of plant origin. In India for instance protein deficiency both in quality and quantity has become so chronic that almost each and every diseased condition is associated with this malnutrition syndrome. Further, our dietary pattern is such that there is always a likelihood of yielding a calcium deficiency particularly of assimilable calcium. Vitamin deficiencies mostly in the form of multivitamin deficiency states are common due primarily to the low intake of protective foods containing essential vitamins. Apart from these generalised deficiency states there are regional physiological disorders arising out of faulty diets. About 20 million people living in the sub-Himalayan region usually suffer from goitre firstly because plant foods grown in that area are poor in iodine and secondly because they consume a lot of the *Brassica* group of foodstuffs which are to some extent goitrogenic. In some other parts of India, another disease called lathyrism is prevalent due to consumption of relatively large quantities of *Lathyrus Sativa* (Khesari). Although its etiology is not yet definitely known it seems likely that it is associated with agricultural production in relation to soil and environmental conditions. Fluorosis is another nutritional disorder caused by the excess fluorine in water in some parts of India.

All these indicate that nutritional studies have already revealed a lot of conditions how food products can influence nutrition and maintenance of health and the importance of their continuance further as food patterns are being changed with social and economic conditions of the country. They further suggest changes in the kinds as well as the amounts of the

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food crops that should be grown for the best use of the land available in terms of the health and economic welfare of the people concerned.

Nutritive value of plant foods in relation to varietal and climatic influences :

Recent studies show that the nutritional value of the plant food supply and particularly of specific food nutrients, apart from the total quantity produced, is governed by various factors such as genetic strain and environment, including climate and soil conditions. There is experimental evidence that the strain and the nature and degree of fertilisation greatly influence not only the yield of a particular crop but also the nutrient-content of a specified harvested crop. It has been shown that a given variety of wheat can vary as much as 20% in protein content according to the locality[50] where it is grown. In a recent communication[29] wide variations in the protein content of pulses have been indicated extending upto 60% in some cases depending upon the strain and the locality where grown. Similar variation in the vitamin content in rice[3] and pulse[26] has been reported. The nutritive efficiency of a high-protein food[30] or of a food associated with high productivity[20] does not alter in many cases in any way. In planning any food production, therefore, we must think something more than increasing the food supply in tons or calories ; every plant breeding programme should take account of nutritive value of food crops in terms of specific nutrients as well as their yield. Agriculture is thus profitably guided by the nutritional studies for meeting nutritional needs through proper food on local or regional basis.

Fortification of foods :

Because of the deficiency or even absence of one or more essential nutrients in specific food crops grown in specific areas and in view of the fact that various foodstuffs suffer significant loss in nutrient contents during milling, refining or other processing, fortification procedures are recommended and enacted in different countries for improving the nutritional quality of foods. Such fortification steps include enrichment of wheat flour, bread, corn meal, corn grits with adequate levels of calcium carbonate and some B vitamins wherever necessary, restoration and retention of B vitamins and iron in milled or white rice and other processed food cereals, addition of vitamins A & D to cooking and table fats, iodine in the form of iodates in table salt and vitamin C to different fruit juice and beverages. Adequate legislation measures for the success of fortification programmes should be enacted by the local and appropriate authorities.

Protein in Nutrition

Out of all the dietary deficiencies, protein shortage both in quality and quantity has become the most outstanding dietary problem particularly in under-developed countries of the world. It is now clear that protein malnutrition is the major cause of morbidity throughout the tropical countries. Its severest effects even in this country are manifested in the most vulnerable groups such as infants and young children, pregnant and nursing women, the aged and the invalids. The term protein malnutrition, therefore, does not mean simply protein deficiency but includes also disturbances primarily induced by low feeding and aggravated by infection

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and infestation converting borderline nutrition to malnutrition. A great deal of our knowledge regarding the basic pattern of dietary protein necessary for the maintenance of health and prevention of disease has been accumulated during the last few decades through the efforts of food chemists, biochemists, physiologists and clinicians. While further metabolic and biochemical work with the available and newly developed protein-rich foods should be continued regarding their suitability and their possible role during metabolism the application of the already available knowledge for meeting optimum protein nutrition through agriculture, food and technology remains the most outstanding problem in public health today.

The primary function of the dietary protein is to supply amino acids for the synthesis of body proteins and other nitrogenous constituents to the normal physiological economy of cellular growth, repair and metabolism. The real measure of the nutritive value of any protein thus lies in its ability to supply not only sufficient amounts of the amino acids but also in their proper proportions. The essentiality of the indispensable amino acids and their minimum daily intake both for growth and maintenance have been studied and determined in recent years[58, 67]. The nutritive quality of various protein foods is being studied with reference to egg or milk proteins because of the well-balanced pattern of indispensable amino acids present in them. The FAO nutrition committee has suggested[39] recently another pattern of human amino acid requirement as a guide for satisfying protein mixture. Those proteins which most closely reflect this pattern of requirements in their indispensable amino acid composition have the highest nutritive value. The quality of protein required will however, depend on the physiological state of the subject, varying in growth, maintenance, reproduction, convalescence and various other stress conditions [26a]. It is not known whether the amino acid pattern and the quantity required for the various stress conditions are the same.

Protein-rich foods from vegetable sources :

Attempts are being made in all directions to increase the production of protein-rich food both on the short-range and long-range basis. The short-range programme includes the development of protein foods by processing and mixing the indigenous food materials for their ready use as food supplement for the prevention and cure of protein malnutrition in people particularly of vulnerable groups such as infants, children and the invalids. The long-term programme should, however, be canalised through agricultural production in a way that the average diet be composed of foods with optimum protein value. Animal proteins such as milk, fish, meat, eggs etc. because of their high content and well-balanced pattern of indispensable amino acids are usually superior to plant proteins which are either deficient in one or more essential amino acids and are imbalanced in their amino acid composition. The availability of amino acids from plant proteins is also limited due to the low digestibility for their high fibre content. Because of our present knowledge regarding the exact pattern of amino acid requirement for optimum health it is however, now possible to prepare protein mixtures exclusively out of plant food materials and as such there cannot be always a hard-and-fast rule for the superiority of animal protein any more. Although an animal protein is generally superior to a protein of plant sources in quality it is more costly because production of animal food such as meat, egg or milk from vegetable sources is dependent on many factors as efficiency of farm animals in utilizing food to produce human food, available acreage, man

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power, cost of labour etc. It has been pointed out by many investigators that the vegetable crops generally satisfy greater requirements so far total calories and other nutrients are concerned if used directly for feeding man than if used indirectly for meat or milk production. The following table illustrates the efficiency of different animals in energy and protein conversion[50].

Animal product	Recovery of gross calories in edible products %	Edible protein produced per therm of diet g.	Efficiency of conversion of feed protein into edible protein %
Milk (Cows)	12—18	4·0	14·5
Eggs	6—9	5·4	9·5
Lamb	3—6	1·7	4·4
Poultry meat	4—6	5·1	13·4
Pork	12—25	4·0	14·5
Beef	3—6	2·0	8·4

Conditions will certainly be different when the animals are fed simply roughage, pasture grass and fibrous by-products inedible by man and when they are reared mainly on concentrates which may for the most part be eaten directly by man. In some cases, however, when a by-product or an agricultural waste can be profitably utilized in feeding the animals for milk or such other food production, animal and vegetable foods are to some extent complementary rather than alternatives. Unless and until production procedures are most efficiently utilised it is difficult to maintain the level of production of such foods within reasonable limits in relation to cost and price structure. The efficiency of production of a very important protective food[49] like milk may be illustrated in the following table.

ANNUAL MILK YIELD PER COW IN LBS. (average)

Netherland	8300	Fiji	1800
Denmark	7800	Iraq	1700
United Kingdom ...	6500	Pakistan	1550
Switzerland	6500	Egypt	1450
Newzealand	5800	Turkey	1150
Canada	5500	Malaya	800
U. S. A.	5300	India	400

While attempts are being made and should be made to increase the production of protective foods of animal origin through animal husbandry, dairying, poultry farming and fisheries yet from socio-economic considerations as prevailing in many parts of the underdeveloped countries of the globe it seems to be difficult to make the country self-sufficient in these foods of animal origin within reasonable period of time. Emphasis, must therefore, be given to raise the production of foods of plant origin containing protective nutrients. Traditionally our diet in this country is predominantly rich in carbohydrates with protein mostly from plant sources such as cereals, pulses and vegetables. If we go through the food production figure for the year 1959-60, we find that out of 71·5 million tons, rice contributed 30 million, wheat 9·75 million, pulses 11·25 million

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tons and the rest is shared by jowar, bajra, maize, barley, ragi and other small millets. Although deficient in lysine, rice has the highest biological value amongst all the cereals. Pulses being the richest source of all the plant food materials that contribute to our daily diet are most important protein-rich food. There are seven important varieties of pulses namely Bengal gram, green gram, black gram, red gram, dried peas, lentil and khesari out of which again Bengal gram contributes about 50% of the total pulse production. Sporadic work that has been undertaken in different laboratories[4, 52] of the country has already indicated that like other vegetable proteins pulse protein is inferior to animal protein in nutritional quality. In view of the increasing importance of pulses as the source of food protein in our diet, a series of investigation have been undertaken by the speaker and his collaborators at the Bengal Immunity Research Institute, in order to observe the position of these pulses as food proteins and the nature and degree of improvement that may be affected in their nutritive value under different dietary conditions. They contain 20-32% protein depending upon the varieties, strain and soil, agronomical and climatic conditions under which they are grown. Their digestibility varies from 85-92%, biological value 45-64% and the growth promoting value (protein efficiency ratio) 1-2, when rats are maintained at 12% protein level for 3-4 weeks[31]. Determination of essential amino acid contens[12, 32, 33, 65] shows that all the pulses are deficient in methionine/tryptophan and when the animals are fed these proteins supplemented with deficient amino acids, the nutritive value is significantly improved. Thus the Bengal gram protein which seems to be the best amongst all pulses studied in nutritional characteristics, when supplemented with the most limiting amino acid methionine as well as threonine gives the highest protein efficiency ratio, comparable to that obtained with casein protein diet [34]. The exact mechanism how threonine plays its role cannot be explained at this stage ; it seems likely that the amino acids which are limiting chemically may not be always so physiologically. The supplementary effect of various amino acids to pulse protein diets in improving the nutritional efficacy has also been indicated in mixed pulse protein diet[35], rice-pulse diet[57] and wheat-pulse diet[30]. The improved nutritive value of pulse protein due to mutual supplementation has been confirmed with rice-pulse diet in human subject[56]. Pulse protein usually contains about 20% of their total nitrogen as free amino acids which may be directly utilized to the best advantage of the subject[27]. The minimum nitrogen requirements from pulse protein diet for the maintenance of nitrogen balance and body weight are, however, higher than those obtained with casein protein diet and although maximum protein efficiency ratio and highest retention in body nitrogen are observed at 10% casein protein in the diet, maximum values of them are found at 12% protein level with Bengal gram protein as the exclusive source of dietary protein[28]. Amongst other criteria for judging the nutritive value of dietary proteins such as determination of plasma protein, haemoglobin, R.B.C., liver protein and some of the liver enzymes most susceptible to the quality of dietary protein such as xanthine oxidase[36], cholinesterase[37], succinic dehydrogenase and aspertic- and alanine-glutamic transaminases[18] are although observed at lower levels from the diet with pulse protein as the exclusive source of protein, they are significantly enhanced with a mixed diet containing rice, pulse and vegetables and are comparable to those obtained from casein protein diet. All these studies thus definitely indicate the possibility of moulding the pattern of an average cereal diet with pulse as the main source of protein-rich food to afford adequate

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protein nutrition, provided the mixed diet is judiciously made. The slight improvement in the nutritive value of pulse protein on supplimentation with vitamin B_{12}[17] under certain conditions points to the further improvement of the diet with daily intake of a little animal protein such as milk.

Oil seeds as protein-rich food :

About 6·5 million tons of various oilseeds such as groundnut, sesamum, mustard, linseed besides coconut, cottonseed etc. are grown annually in India. After extraction of the oil, a large portion of the oil cakes goes straight to feed the livestock Industry. These oil cakes usually contain 40-45% protein which can be extracted with sodium chloride solution or with dilute alkali whereby the proteins are peptised and then precipitated at lower pH[41]. Determination of their amino acids composition by paper chromatography[60] showed that they are good sources of essential amino acids and their utilization by proper processing as protein-rich food was indicated[5] as early as in the year 1946. Since isolation of the proteins by peptisation and precipitation entails the loss of water soluble vitamins and minerals attempts have been made to prepare protein hydrolysate for human consumption as protein-rich food supplement by digestion with enzymes from *aspergillas oriza*[40] and papain. By controlling the digestion and processing at low temperature a concentrated protein digest[19] can be obtained which on supplementation with methionine and threonine affords a nutritional quality comparable to that obtained with milk protein[21].

The Nutrition Division of the Food and Agriculture Organisation and the nutrition section of the World Health Organisation are jointly taking leadership in improving the nutritional status of the people in different countries. Because of the present shortage of milk and skim milk integrated efforts are going on under the auspices of the United Nations International Children's Emergency Fund (UNICEF), FAO and WHO of the United Nations and with financial assistance from Rockefeller foundation and other agencies, for the production of protein-rich foods from the indigenous vegetable sources. Some 23 grants in 18 countries are currently active in the basic research for their production, pilot plants, field trials and acceptability tests. In India at the Food Technological Research Institute low cost protein-rich foods mostly from Bengal gram and groundnut have been developed and various field trials at different parts of the country are going on regarding their suitability and acceptability as a supplement to the diet of infants and children and in the prevention and cure of protein malnutrition cases. Some of them are giving encouraging results[61]. In selecting a protein-rich food other than milk the following criteria are to be considered : (i) It should be produced locally (ii) its production and purchase must be feasible for all sections of the population from the agronomic and economic stand points, (iii) it should have a long storage life without refrigeration under the prevailing conditions of heat and humidity and must be easily transportable, (iv) it must be free from any toxic or other deleterious agents, (v) it must be acceptable with regard to taste, odour and physical properties and (vi) its protein value must be such that it may effectively supplement existing diets.

In developing newer types of foods either from natural sources or through industrial proceeding it is necessary, however, to consider the

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importance of dietary patterns that exist in different sectors of the country. These patterns are the results of age-old experiences and accumulated wisdom and any drastic and sudden change may lead to manifold troubles. Modifications, however, must take place but recommendations should be made with the full knowledge of both the immediate effects and later consequences.

Balance in amino acid composition :

In developing and/or processing protein-rich foods and protein in average diet care should be taken in keeping the over-all amino acid composition in balanced form. Ill effects of imbalance resulting from supplementation with higher level of deficient amino acids have been reported from both experimental and clinical studies in recent years. Supplementation of a low protein diet with the deficient amino acid methionine precipitated threonine deficiency that caused increased deposition of liver fat[44]. Inclusion of threonine in a low protein diet deficient in niacin caused a severe depression in growth which could only be corrected by adding niacin or its precursor[48]. Deficiencies of certain B vitamins have also been made worse by the addition of certain amino acids to the diet[46]. Harper and coworkers[45] have demonstrated that in rats fed a predominantly rice diet, a lysine supplement adequate to prevent the development of fatty liver also promoted secondary deficiencies of other amino acids resulting in growth retardation. The results of these and other similar studies thus indicate three possibilities[15] : (a) Increase in the supply of the most limiting amino acid in a diet poor in protein may provoke deficiency of the next most limiting amino acid, (b) Excess of an amino acid may reduce utilization of other amino acids present in normally adequate amounts and thus may provoke a deficiency, and (c) Excess of any amino acid may increase the severity of a marginal deficiency of the vitamin B complex. Exactly in what way these imbalances upset the normal metabolism is not clear and further work is necessary before any generalisation can be made[43].

Interrelationship between dietary protein and vitamin A in metabolism :

High prevalence of xerophthalmia and other eye lesions attributable to vitamin A deficiency in children suffering from kwashiorkor and other protein malnutrition states have been reported by many workers in recent years[1, 2a, 42, 54]. The association of keratomalacia with various protein deficiency syndromes such as nutritional oedema[51] billiary cirrhosis[68], fatty liver degeneration[87] etc. has been reported from China, India, Ceylone, Malaya, Africa and other countries where protein malnutrition is prevalent. In what exact way protein and vitamin A deficiency may affect the metabolism of each other is not known but it seems likely there is some interdependence for proper absorption, transport, storage and utilization. Preliminary studies, however, indicated that the absorption and storage of vitamin A are adversely affected under certain conditions of protein feeding and vitamin A influences the metabolism of protein[10, 25]. A series of investigations has recently been reported by us regarding the possible interrelationship of dietary protein and vitamin A in metabolism with special reference to vegetable protein. Although quality and quantity of dietary proteins have no influence on the absorption of vitamin A, continued intake of both low and imbalanced protein results in low storage of vitamin A in the liver.[24] Earlier depletion of vitamin A from the liver and lower plasma vitamin A have been observed under conditions

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of feeding imbalanced protein such as pulse and cereals and at low level of milk protein.[22] High intake of vitamin A has been found to enhance both the weight gain of the animals and the level of certain enzyme activities in the liver such as cholinesterase, DPNH-Cytochrome C reductase, xanthine oxidase and succinic dehydrogenase when the diet contained either imbalanced protein and sub-optimum level of casein protein.[23] Vitamin A deficiency tends to cause a marked decrease in the nitrogen efficiency, nitrogen retention and decline in total plasma protein with consequent elevation in non-protein nitrogen in plasma and liver.[7] The most recent findings tend to indicate that the sub-optimum intake of vitamin A shifts the subject from the positive nitrogen balance to a negative one[8]. During some clinical studies[9] it has been observed that ingested proteins and amino acids are not adequately utilized in some refractory cases. The effect of supplementing vitamin A is being followed in these cases. All these studies tend to establish that a balance between dietary protein and vitamin A exists in metabolism and this balance is seriously affected when the intake of protein is inadequate or vitamin A supply is sub-optimum.

Influence of hormones in protein metabolism :

One of to-days most challenging problems in cellular physiology is how the several hormones may operate at the cellular level to produce the changes in metabolism in specific organs which are evident as changes in growth and activity. The endocrine control includes an adjustment of metabolism through the interaction of numerous hormones activity in specific biochemical or biophysical areas to produce optimum substrate concentration, adequate enzyme activity and appropriate work performances in all organs and tissues in a variety of physiological and pathological states. Both the synthesis and degradation of hormones are dependent on enzymes which are all proteins and dependent on dietary proteins and perhaps all the physiological effects of hormones are brought about by their regulation of specific enzymetic reactions within the cell. Although the normal growth depends on many factors, some hormones such as growth hormone of the anterior pituitary, estrogens, testosterone and other androgens, insulin, thyroxine and other thyroid hormones play a great role by promoting the storage of nitrogen as tissue protein and thus stimulating a positive nitrogen balance. Lower level of growth hormones has been observed during feeding protein-free or restricted protein diets[62]. Testosterone and similar synthetic steroid hormones have been observed to influence the metabolism of vegetable protein in the diet[14]. Te action of adrenal corticoids appears to be often protein catabolic but the net effect of this action as gluconeogenesis and urea formation has been found quite variable. Our knowledge regarding inffuence of hormones and body stress conditions on protein metabolism is yet limited. How the amino acid sequences of various systemic hormones such as ACTH, anterior growth hormones. insulin, oxytocin, vasopressin etc. vary between species to species yet retaining their biological/physiologic characteristics? Do they all respond in a similar way to all types of dietary proteins. All these and similar problems need solution. The net outcome of numerous apparently opposing hormones depends greatly on their mutual balance amongst themselves and other nutrients. Similar interrelationship exists betweesn vitamins and hormones about which we are going to hear in a symposium arranged during the current session. In maintaining these balances dietary proteins are undoubtedly playing a great role.

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Mechanism of Nutrition and Metabolic Disorders

Nutrition Research so long had been largely concerned with establishing the dietary origin of diseases and isolating the deficient nutrients. Great strides have also been made in working out specific chemical reactions involving vitamins, enzymes, hormones etc. An understanding of the mechanism of nutrition implies why nutrients are required, how they are used by the body and an accurate conception of the complex interrelation of nutrients within the body. Dietary inadequacy and defective utilization of nutrients are closely related problems. Many end results of metabolic dysfunction are often recognizable afterwards clinically. We have gradually attained a position of detecting an approaching metabolic deficiency to avert a metabolic disease in future. Thus the frontiers of nutrition science have been extended to the studies of various chronic diseases such as hypertension, diabetes, atherosclerosis, arthritis, cancer, degeneration of the liver and kidney and other diseases of the aging population and the process of aging itself. The pathogenesis of many of these chronic diseases may be traced back to faulty maternal and infant nutrition, some to inborn errors of metabolism and others to peculiar patterns of average diet, the consequences of which manifest themselves in later years clinically. Our limited knowledge regarding the relation of diet with the etiology of some of these disorders is illustrated below :

Diet and atherosclerosis :

The relation of dietary fat and of serum lipids, particularly cholesterol with the pathogenesis of atherosclerosis has been the subject of increasing interest in recent years. This has stimulated extensive investigation of fat matabolism in experimental animals and man. Although we have gained much knowledge on various aspects of lipid metabolism by these studies, the postulation that a direct causal relationship between dietary fat, serum cholesterol and the development of atherosclerosis exists has not been definitely established and has undergone numerous modifications. This is because firstly the formation, absorption, circulation and excretion of cholesterol are dependent not only on the quality and quantity of dietary fat but also upon other dietary factors such as the quality and quantity of protein, carbohydrates, plant sterols, vitamins and others ; and secondly, many other factors other than diet such as heredity, hypertension, diabetes, obesity, age, stress, vascular trauma, sex, hormones, liver function etc. exert prominent roles in atherogenesis and thrombosis and the whole problem is not so simple as was once comprehended. For preventive measures it has been considered, however desirable to maintain the normal cholesterol level by dietary means.

A diet usually contains three kinds of fats, saturated, mono-unsaturated and poly-unsaturated in widely varying proportions. All of them do not have the same effect on the amount of cholesterol in the blood. Those high in saturated fat tend to increase the cholesterol in the blood, those high in mono-unsaturated acids have little effect and those high in poly-unsaturated fats may cause a decrease. Vegetable oils excepting coconut oil which are usually rich in poly-unsaturated fatty acids including essential fatty acids and some fish oils rich in a variety of other types of poly-unsaturated fatty acids usually keep the serum cholesterol level low. It is not possible to give here the detailed knowledge regarding the lipid metabolism but a balance amongst the various lipid constitutents in the serum such as triglycerides, phospholipids, β-lipoproteins and cholesterol (both dietary and synthesised in the body) should be achieved through the

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diet and dietary fat. Until our knowledge on this problem is more clear and definite, for preventive measures it is desirable that our diet should contain less saturated fatty acids and more poly-unsaturated fatty acids including some essential fatty acids like linoleic and linolenic acids.

Inborn errors of metabolism :

The concept of inborn errors of metabolism was introduced by Garrod in 1908, who dealt with four specific metabolic disorders—albinism, alkaptouria, cystinuria and pentosuria. The number has by now increased to more than fifty and is still rapidly growing. All these hereditary metabolic diseases result from defects in single genes with resultant defects in single enzymes. Products excreted are in reality normal metabolites which accumulate because of deficiency of enzymes responsible for further metabolism. For instance phenylketonuria[68] about which detailed study has been made in recent years is characterised by the failure to hydroxylate the amino acid, phenylalanine, to form tyrosine and results in the accumulation of execessive amounts of phenylalanine in the body and in its excretion together with its derivatives in the urine such as phenyl-pyruvic, phenylacetic and phenyllactic acids. The disability is manifested only several weeks after birth, first with elevation of plasma phenylalanine to 30 times the normal level and the excretion of phenylpyruvic acid. After six months of age, retardation of mental development is noticed. Neurological abnormalities and seizures, decreased pigmentation of hair and skin, and eczema may develop. In older children and infants the process remains stationary. Similar revealations are also being made in other diseases. With the unravelling of the mysteries of intermediary metabolism, these diseases have aided in the comprehension of metabolic pathways. Studies on the inherited blocks are influencing the development of our concepts of biochemical genetics. The metabolic abnormalities studied by Garrod were of such a nature as to be detectable from the time of birth. Other heritable defects may become manifest only later in life. Typical of such a disease is diabetes mellitus, heritable nature of which has been indicated long before. There is yet no precise explanation for the nature of this disorder which occurs at variable ages. It is not unlikely that many other diseases have a similar underlying etiology. With the development of newer and newer techniques it is becoming possible to detect these disorders at an early stage and preventive and curative measures through the regulation of diet seems feasible. Future work in enzymology and human genetics is expected to clear our understanding of the pathogenesis of many metabolic diseases.

Metabolic interrelationship in diabetes mellitus :

With the development of newer techniques our ideas regarding the pathogenesis of diabetes mellitus is gradually becoming clear. Even after the discovery in 1921 that the cause of the disease is a primary deficiency of insulin, the course and the complicated nature of this metabolic disorder has remained one of the most puzzling and challenging problems to the biochemists, physiologists and clinicians. The most recent studies tend to indicate that the primary abnormality in essential diabetes is increased atagonism to insulin which the diabetic subjects presumably inherit[64]. The primary cause of both juvenile-onset and maturity-onset human diabetes is likely to be an abnormally high level of insulin antagonists bound to plasma albumin[63]. These are possibly polypeptide in nature and mediate through the pituitary-adrenal system. As such their release is expected to increase under certain conditions—

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such as growth, pregnancy, infection or mental stress—times and situations which are known to precipitate the diabetic state in susceptible people. Further as the insulin antagonism occurs in muscle but not appreciably on fat, the high levels of plasma insulin found in prediabetes and early diabetes may actually favour the growth of adipose tissue—in other words the obesity so commonly found in newly diagnosed diabetics aged 40 or more. The time and type of onset of the diabetic state thus depend on the degree of antagonism as influenced by inherited liability and on the resilience of the pancreatic β-cells in responding to this challenge. Further work regarding the nature and characteristics of albumin-borne insulin antagonists is likely to place the pathogenesis of this metabolic disorder on a more clear-cut basis. What type of dietary constituents can intensify or minimise the complication of the disease will be easier to formulate then and then only.

Nutrition and Cancer :

Various epidemiologic studies indicated that nutritional factors may play a role in the development of some types of cancer in man. Because of the complexity and multiple etiological nature of the problem the direct proof of a cause and effect relationship has rarely been obtained. There is some evidence that body weight status which reflects both caloric nutrition and basic body habitus is associated with a varying incidence of malignant disease. Experiments in animals have demonstrated that both spontaneous and induced malignant growth occurs less frequently under marked calorie under nutrition[59] although lesser degrees of under nutrition produced little or no beneficial effect. High incidence of hepatic carcinoma has been observed amongst population in certain parts of South Africa manifesting signs of chronic malnutrition. The causative factors may be deficiency of protein and B vitamins in their diet[6], although the influence of some other factor/s cannot be ruled out. The coincident occurrence of endemic goitre and thyroid carcinoma in areas where iodine intake is low places this malignancy in the category of being nutritionally induced in many cases[66]. The relatively high incidence of carcinoma of postericoid region of the hypopharynx in Swedish women has been linked to the so called Plummer-Vinson syndrome[2] which responds well to iron therapy. Whether this is specific has not yet been established. Certain types of potentially premalignant lesions in the mouth are suspected to be nutritional in origin. The lesion occurs with some frequency in chronic alcoholics whose nutritional status is poor and the fact that tissues of the mouth are commonly affected by B vitamin deficiency have led to the suspicion that these nutrients are in some way involved in the hypertrophic process[70]. Some types of food or drink may contain substances either through natural circumstances or as additives or contaminants which have been demonstrated to produce neoplasm particularly in the gastro-intestinal tract. The conventional nutritional survey concentrating on nutrient intake and general nutritioal status are often likely to miss the point in seeking for a cause and effect relationship between diet and malignancy. Further concentrated work may reveal definite causative factors when dietary measures will be more feasible in the prevention and cure of the disease.

Nutrition during old age :

Comparatively much less work has been done regarding the dietary requirements of the old people for optimum health and longivity of life. This is because metabolic balance studies in the elderly subjects are

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complicated with various other factors. In many cases they have a diminished gastric, intestinal and pancreatic secretions and an alteration in the amount of hormones secreted by the endocrine glands. Results of the epidemiological or longitudinal studies are also to be interpreted cautiously because diets of the old people are likely to be inadequate due to various factors such as lack of financial resources, ill health whether mental or physical, difficulty in mastication, inability to collect and prepare foods, loneliness etc. It is now established that a little reduction in calorie intake is beneficial as the people grows older. FAO[38] has recommended a reduction of 3% in the requirements for age for each of the decades 25 to 35 years and 35 to 45 years, a reduction of 7·5% for the decades 45 to 55 and 55 to 65 years and a further 10%, reduction for the decade 65 to 75 years. A modification of such reduction in the calorie requirement for the elderly people seems to be necessary in view of the fact that such requirements will vary according to the composition of the body, the musclemass and the energy expended. Some studies have indicated low levels of B vitamins in elderly people but it is not known whether they are true deficiencies or secondary deficiencies due to malabsorption. There are evidences that with the passing of years intestinal function and intestinal flora are being altered to an extent influencing nutrition. The development of osteoporosis during old age resulting in serious disability needs to be thoroughly studied in relation to calcium requirement for preventing bone defect. Some longitudinal nutrition studies[13] conducted in a population of healthy elderly people varying in age from 50-89 years have yielded interesting results. Incidence of anemia was surprisingly small and lower mortality was observed in the subjects who had high intakes of vitamin A, niacin and vitamin C. Protein intake had little effect on the incidence of illness of the nervous and circulatory system. Similar rarity of the illness was observed in groups who had intake of vitamin A above 8000 i.u. and vitamin B_1 above 0·8 mg. daily. Such studies if conducted adequately are expected to yield far-reaching results regarding the optimum requirements of dietary essentials and management of the old people.

The advancing front of nutrition research is thus revealing more and more fundamental knowledge on the complex problem of biochemical reactions in man. New principles of pathogenesis are emerging from the combined contribution of biochemistry, biophysics, genetics and other basic scientific disciplines. The application of these informations to the study of various disorders may soon lead to effective preventive measures.

Drug and Nutrition

Rapid development of biochemistry in recent years have increased our knowledge of the role of specific enzymes in the chemical operation of the living cell and one of the methods of judging the effectiveness of a drug is the extent how it can correct the altered body mechanism during various pathological conditions by modifying the enzymatic pathways. The word 'drug' may now also include various essential metabolites such as vitamins, salts, hormones, amino acid etc. whose presence in abnormal quantities may induce new biochemical and physiological changes thus disturbing cell equilibrium as efficiently perhaps as the administration of some of the well-known exogenous drugs. Moreover, substances intrinsic to metabolism when applied under certain conditions may have a medicinal function bearing no apparant relation to their usual metabolic role.

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Vitamin B_6 for instance has been found to clear up many complications of neuritis developed during isoniazid therapy. A number of drugs of diverse origin are capable of increasing synthesis and excretion of ascorbic acid in rats[53] ; guineapigs cannot metabolize aromatic drugs at a normal rate when deprived of ascorbic acid. A variety of aromatic drugs are apparently metabolised by chemical reactions in which the vitamin is a common denominator. Similar relationship can be cited between inorganic minerals and the various enzyme systems influencing the body mechanism. The relation of certain nutrients to the function of adrenal cortex is a subject of great interest in various health problems such as stress and rheumatic arthritis. In such relationship various nutrients such as ascorbic acid, pantothenic acid, cholesterol etc. play a great role in the synthesis, elaboration and function of various corticoid hormones and their imbalance results in acute and chronic disorders. These are some of the numerous illustrations of the interrelationship of various nutrients in the body. Research in metabolism is thus gradually building toward an over-all view of body chemistry and in this body mechanism all the nutrients are playing drug like roles for maintenance of health and longivity of life.

Conclusion

The broad possibilities of the science of nutrition for human welfare are thus leading to an intricate interplay of both national and international forces involving agricultural, medical, technological, socio-economic and cultural factors. It is thus a rapidly advancing field of knowledge and research. Improved knowledge of nutrition and its application have rendered people of the advanced countries of the world a much better living standard, health, longivity and productive efficiency. In the public health side although medical research has just begun to clarify many intricate relationship between human nutrition and chronic diseases, there is a constant flow of fresh scientific observations which are of immediate value to practising physicians in the management of such disorders. In India although we have given a start in the right direction, but all efforts are to be intensified as the occasion demands. We have vast resources in man and material, we have also numerous problems. Food production plans are to be reoriented according to the nutritional needs of the people and plant breeding programmes are to be based on both increased yield and nutritive value of the specific food crops. Studies on the nutritive value of all available food crops should be continued so that the results may be readily utilized for computing an average diet. Other agricultural tasks include technological problems of efficient utilization of available raw materials and searching for new food-stuffs. On public health side although we have got nutrition sections even at the state level, they are still to function properly[55]. Diet and nutrition surveys are to be conducted more intensively and extensively with a view to determine the food habits, dietary pattern, food requirement at all ages and incidence of deficiency diseases. Preventive measures and curative agents should be found out locally and efforts for their industrial production from the indigenous resources are to be encouraged and intensified with the help of available knowledge. In all these problems, while fundamental investigations will go on, more efforts are to be canalised in the application of already available knowledge thus avoiding the danger of too much attention being paid to fundamental

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research and too little to the development of what is already known. It is desirable to set up a unified agency for co-ordinating efforts and planning the nutrition programme. Our greatest mission at the present moment is to free people from hunger, disease and disability, and to substitute malnutrition and under-nutrition with better standard of living, health and well-being and in this mission of urgent nation building tasks, physiologists can play the greatest role.

Let me conclude by expressing my grateful thanks to Dr. U. P. Basu, Director of this Institute, with whose untiring energy a nutrition research centre could be organized and to my other colleagues with whose energetic co-operation a team work is being rendered possible, so essential in such studies.

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SECTION OF PSYCHOLOGY AND EDUCATIONAL SCIENCE

President :—Dr. G. D. Boaz, M.A., D.Phil (Oxon)

PRESIDENTIAL ADDRESS

THE CONCEPT OF MIND

Friends,

Allow me to express my sincere thanks for electing me unanimously to this honoured position of the President of this section.

On seeing the title of this address, some of you may be amused, some become really curious and some may even feel disappointed and disgusted though they may not express those feelings. It should be so, since I am privileged to address a group of human beings and not a collection of machines like Grey Walter's famous *Machina Speculatrix*. For, all of you have your own inner world of feelings, prejudices, expectations, dynamics of motivation 'emitted' responses and ideas and symbols of personal creation. The machina speculatrix is a remarkable electronic machine resembling a large toy tortoise. It is driven and controlled automatically by batteries under the outer shell. It is fitted with a small bulb on its forehead. The internal electronic system is sensitive to two things, light and touch. Because of the combination of these two the machine can perform astonishing feats. It constantly seeks a homeostatic equilibrium of light of the right intensity. It can actually seek out a light of the proper intensity with amazing skill, avoiding obstacles and other difficulties. This skillful manouvering is done because of its sensitivity to touch. It will violently avoid a powerful light. When its own forehead light becomes weak because of the running down of the batteries, it finds its way back to its 'home' being led by the weaklight of the 'home' and get recharged. It is agreed that it is almost thrilling to watch a few of these machines put together. Perhaps, we can make them still more wonderful by making them sensitive to more sensory patterns, like hearing and smell. I can well imagine my being confronted with a few of them at one time. I will be amazed, and the kind and degree of feeling each will evoke will be the same except perhaps, if they are painted differently my aesthetic feelings may be different. But my reaction to their performance as objects of reality in my environment, will be the same. Truly speaking, if I rise above childish level of reasoning, the amazement and wonder is not about the machines themselves but about the mind which created them. Now let me imagine myself being confronted by a few of you. My reactions will be different, about some I may not feel any wonder at all, and some may give me a unique satisfaction which is incapable of being fully analysed and defined.

Like any other philosophical or scientific concept, the concept of mind also has its own history. Beyond a brief indication, no details of this history will be attempted here. It is agreed that Descartes marks an

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important stage in this history. Though the problem was always there in Greek Philosophy, Descartes formulated the well known theory of dualism which has since then come in for its full quota of discussion. In fact, the entire subsequent history of this problem has been centering around the Cartesian theory of dualism. At this stage, it is perhaps unnecessary to go over all the controversy carried on by philosophers however eminent they may be. But it may be recalled that perhaps Pavlov and Watson contributed most to the apparent dislodging of Cartesian dualism from scientific psychology.

The stand taken by most of the behaviourists does not really say anything about the existence of mind as an entity. Their observations merely point out that an entity called mind cannot be studied scientifically. This is only an evasive technique. The concept of mind at once raises the philosophical issue of body-mind relationship with which scientific psychologists cannot be bothered. The positive affirmation of all behaviourists has only been that mind cannot be studied in the way objective behaviour can be studied. Hence, mind as a hypothesis can easily be dispensed with, is the real contention. We find this affirmation even outside the fold of academic psychologists. Ashby who gave so much of hope to the behaviourists declares that the fact of the existence of consciousness is prior to all other facts. But, he continues "Science deals and can deal, only with what one man can *demonstrate* to another. Vivid though consciousness may be to its possessor, there is as yet no method known by which he can demonstrate his experience to another. And until such a method its equivalent is found, the facts of consciousness cannot be used in scientific method". This sums up all the available objections against a psychology using the concepts of mind and consciousness. Thus their position is a confession of failure to evolve suitable methods. However, the history of psychology is the history of brilliant men devising now and then acceptable methods for quantifying psychological data often belonging to the realm of intangible phenomena. Hence, it is equally feasible to try and hope to find suitable methods to study the concept of mind also as it is to give up this concept. In the study of psychology instead of subject matter determining methodology, methodology has determined subject matter. It is here that Titchener was definitely superior to Watson. He defined the subject matter and proceeded to develop methods. Watson on the other hand defined the methods first and then had to limit the subject matter.

We began with a reference to Grey Walter's automatic tortoise. One need not be a student of electronics to appreciate and wonder at the achievements of the human intellect in the field of electronic machines of various kinds and for various purposes. Flying with remote controls, the chess playing computer, the electronic brain are all wonderful. But somewhere, however far away, a human being has to sit at the controls. These electronic achievements are based on the feed-back mechanism which brings into action self-regulated controlling devices. A successful and pragmatic understanding of the feed-back mechanism and the fact that for many purposes electronic devices of this kind are far more efficient than the human brain, suggested the question in Man's insatiable mind, is this then how the mind works? It raised hopes, mind you in the human mind. These hopes can be best expressed in the words of John Grayson "Such is the remarkable achievement behind the present day popularity of the electronic brain, a concept that has permeated modern life. It is the battle cry of the modern materialists. And the exploits of these remarkable accumulations of valves, transistors, wires

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and what have you, increasingly encourage the view that the constructing of a sort of super brain, with all the attributes of the human brain and more, is just around the corner". The one problem which faced these modern materialists was the extreme adaptability of the nervous system in man and the higher animals. They beleived that if this problem could be solved the quest for a man made mind, or virtually a man made man would be an accomplished fact. Ashby devotes a whole book for this purpose, "Design for a brain". Though the appendices are really tough for a lay-man, one can profitably go through the major themes of the book which explain or at least try to explain characteristics of animal behaviour like adaptability, stability, constancy, independence, etc., in terms of electronic concepts like, step functions and part functions.

Though the book was published in the year 1952, Ashby draws most of his psychological and physiological material from very early and out of date publications. Many defects have been pointed out against interpreting nervous functions form the analogy of the homeostat. Grayson draws our attention to the fact that homeostats show no gradation in success, either it adapts successfully and completely or it does not adapt at all. But not so, the human being. There can always be gradual learning through errors and partial success. Grey Walter himself is reported to have stated that electronic computers and other devices described as models of human behaviour bear no more relation to the human brain than a hacksaw does to the human hand. John Cohen points out a significant difference "No better example of a characteristically human experience can be found than 'blushing', which Darwin singled out as the most peculiar and the most human of all forms of expressive behaviour. Blushing cannot be caused by any action on the body. The mind must be affected. Even Dr. Ashby's homeostat has not yet blushed and is unlikely to do so unless at the thought of how far it falls short of its master's aspirations.....This is only one of innumerable examples which show that no understanding of experience is possible if we assume that consciousness and attention are nothing but occult qualities gratuitously introduced into the palpable world of anatomical reality".

Further, Ashby's description of the mechanical brain leaves you with a feeling of missing something. You don't feel that the whole of individual or social behaviour is accounted for. Neither the concept of static homeostatics nor that of dynamic homeostatics can explain the restlessness of individuals and groups, the love of novelty, and the spirit of adventure. Even a casual observation of man, as he has lived over these centuries, will show how almost day by day he creates new needs and goals. The history of our society and culture testifies to the fact that man continuously breaks new grounds with regard to his needs and their satisfaction. Certainly it is not a striving to restore any homeostasis. The real character of human behaviour is to distrub the homeostasis at every stage and progress towards ever receding and widening states of *pragnanz*.

Nor can we explain human behaviour in terms of adjustments to a situation, original or fed-back stimuli. This is a very poor view of human behaviour indeed! Man is not known for the adjustments he makes, but for stepping beyond the range of available stimuli and creating his own stimuli and environment. A spontaneous creativity is what we miss in an electronic brain. You may build in a million adaptations and variations. The resultant behaviour can be made very complicated almost showing choice. But it has to be one out of this million and never outside it.

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Human behaviour also has another particular kind of adaptability or variability. It is possible and it does happen often, for the entire present system of stimulus reactions be negated and thrown aside and an entirely new scheme of behaviour to emerge, something that was not previously noticed, and something that was not built in already as in the homeostat. In other words in human behaviour there is real spontaneity.

Thus we can now safely hold that all attempts at reductionism championed by scientists like Rudolf Carnap and many other students of Cybernatics have not been satisfactory. We cannot accept the suggestion that the brain is nothing but a conglomeration of electronic circuits and biological transistors. Mind still seems to challenge the minds of those gigantic intellectuals.

At one stage, it was the neurophysiolgist who inspired the hopes around the electronic brain. But that was more because neurophysiology itself was just beginning to understand the minor structure and functions of the brain and the central nervous system.

The study of the nervous system began with a purely physiological approach which did not allow any reference to what we call intellect. But the neurophysiologist soon opened up new mysteries of the nervous system. Purely from the physiolgical point of view, all the complex behaviour of animals and man can be explained as a compensation for the lack of chlorophyl. Because plants have chlorophyl they do not have and do not need a nervous system which is the basis of mobility. The nervous system was necessary for the animal since having no chlorphyl it has to move out and seek its food. Thus the beginning may be so mundane, but even right there one sees a purposeful mobility. Development of the nervous system has gone on since then at a tremendous pace, every advance requiring highly specialised functions and structure. An increasing knowledge of the brain structure soon revealed to the neurophysiologist that the brain is not just a machine. Scientists like Harvey Cushing, Sherrington, Penfield and Eccles have really opened up new possibilities by admitting ignorance at various points. The more they unravel, the more they feel the need for a concept of mind as a separate entity. One physiologist declares that the central theme in all our cerebral activity is consciousness and this we know nothing at all about beyond the bare statement that the food and drink of consciousness are memory and sensory appreciation. This lack of knowledge on the part of physiologists about the causal relevance of psychic phenomena to the brain, made R. W. Gerard say "it remains sadly true that most of our present understanding of mind would remain as valid and useful if, for all we know, the cranium were stuffed with cotton wadding. In time the detailed correlation of psychic phenomena and neural process will surely come ; but to-day we are hardly beyond the stage of unequivocal evidence that the correlation does exist".

Without any fear of being labelled as an outmoded cartesian philosopher, Eccles raised the following questions in clear and unmistakable fashion in his Oxford lectures on "The Neurophysiological basis of mind". What manner of beings are we? Are we really compounded of two substances spirit and matter? What processes are concerned in perception and in voluntary action? How are conscious states related to events in the brain? How can we account for memory and the continuity of mental experience that gives the 'self'? How is that entity called 'self' interrelated to that thing called a body? These questions are certainly very encouraging to the psychologist and the philosopher. The very same

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electronic techniques which gave hopes to materialistic monism have now led the neurophysiologists to accept some form of Cartesian dualism and interactionism as a valid working hypothesis in the attempt to obtain further scientific insight into man. After a highly technical discussion of the nervous system with all its functions like the reflex arc, transmission, inhibition, synaptic plasticity, Eccles concludes (I beg your pardon for a long quotation). "It should be pointed out that, in this discussion of the functioning of the brain, it has initially been regarded as a 'Machine' operating according to the laws of physics and chemistry. In conscious states it has been shown to be in a state of extreme sensitivity as a detector of minute spatiotemporal fields of influence. The hypothesis is developed that these spatio-temporal fields of influence are exerted by the mind on the brain in willed action. If one uses the expressive terminology of Ryle the 'ghost' operates a 'machine', not of ropes and pulleys, valves and pipes, but of microscopic spatio-temporal patterns of activity in the neuronal net woven by the synaptic connections of ten thousand million neurones, and even then only by operating on neurones that are momentarily poised close to a just-threshold level of excitability. It would appear that it is the sort of machine a 'ghost' could operate, if by ghost we mean in the first place an 'agent' whose action has escaped detection even by the most delicate physical instruments."

The problem of body-mind or brain-mind relation is an entirely different matter. Because we do not have much light on that, we cannot deny either mind or brain. Even here Eccles has some suggestions. According to him, there is ample basis for the hypothesis relating to the operation of the mind on brain. But the reverse, viz., traffic from brain to mind is at the present state of neurophysiological knowledge only a pure speculation.

Many of the psychic phenomena could be fully understood and appreciated only on the assumption of an entity which we call mind. Intelligence for example cannot be understood without accepting consciousness. Intelligence involves consciousness and a motor component. It involves memory. More than all this, it involves a central integration so that a situation may be appreciated in toto. And the whole phenomenon depends on an immediate perceptual awareness. No wonder Spearman formulated his three axioms of noegenesis, the first of which refers to this perceptual awareness. It is the very work of mind itself and not the end-result or the by product of a series of neuronal activities. We may also perhaps find some connection between the Gestalt theories of perception and insight with the direct influence of mind on the brain producing what Eccles calls the spatio-temporal patterns. Space, time and meaning, always are problems to the materialist. Even truely as a hypothesis it seems necessary to bring in mind, for neurophysiology has not detected anything so far to explain these in terms of the physical activity of the brain. Among the psychologists, J. P. Guilford gives special importance to the fact of consciousness in its relation to mind. Discussing the structure of intellect as a three dimensional morphological model and the various operational abilities involved such as cognition memory, divergent production, convergent production and evaluation, he says "It may be suggested, however, that consciousness provides enormously increased potentialities for making discriminations and hence for information". He says further "If we want to keep the concept of "mind" in psychology, it can be regarded as a set of operations applied to different kinds of information, yielding certain kinds of products". And

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we may add that the brain by itself has no structural frame for such activities involving conscious intelligent information-processing.

We have not yet begun to take seriously the persistent challenge offered by parapsychology. It is nothing but the ostrich policy to disregard totally from our psychological problems the data and results obtained through rigorous experiments by scientists like Thouless, Rhine, Murphy, Soal and others. Studies on telepathy, extra-sensory perception and psychokinesis strongly indicate the necessity for the concept of mind and also offer evidence for a two-way traffic between mind and brain. It is perhaps true that the parapsychologist has not yet been able to offer a satisfactory concept of mind and its relation to body. But this cannot justify an indifference to the experimental findings. Perhaps the parapsychologist himself is afraid of being criticised as a speculative philosopher.

It has been suggested by many western psychologists that we in India are better fitted for various reasons to take up seriously the challenge offered by Parapsychology. Whether one agrees with this or not, it is certainly a discipline that could be followed more seriously by Indian Psychologists. At least there are plenty of philosophical concepts which could be sifted and adopted as tentative hypotheses. Phenomena like telepathy will also raise several other questions, not merely the problem of body-mind relation, but also that of mind-to-mind relation which may frighten us all the more because of the possible philosophical implications. Simply because, we have studied some psychology and done some laboratory experiments, and that mostly perhaps connected with testing and measurement, we cannot rudely brush aside the experience and accumulated intellectual achievements in the field of philosophy and religion.

Perhaps it may occur to you that so far I have only been indicating the possibilities for the existence of mind as an entity and not necessarily for including its study within psychology. In fact, as I mentioned earlier, that was the real position taken by many behaviouristic psychologists. Shall we then leave it to the philosopher and the neurophysiologist? We can expect some leads from them. But the entity itself is closely bound up with our discipline. If concepts like intelligence, perceptual awareness, willed activities, creative imagination, come within the scope of psychology, we cannot be content with merely measuring them, but also should be able to explain their basis which seems to be mind. We are, prepared to use and study the word 'insight , for example, because it has been introduced with a clothing of scientific experiments. But it is really an interpretation. Yet, we will not dare use the term 'intuition'. The two may be very closely related, only, we have not yet cared to clothe this latter term with the same garb. Simply because we have come away from the tents of philosophy, it does not mean that we cannot take a honourable look at the furniture of our original home.

The relationship between the cerebral cortex and the diencephalon is interesting to note. The mysteries of biological life are all associated with the brain stem. But in man, it is the world of values created by him that determines what will be allowed into the consciousness. In other words, the cortex also is an agent of the world of values and traditions that we have created. This is why we get the censorship. The brain-stem is completely unaware of this aspect of the environmental world of man. Hence, the brain stem is not in harmony with conscious mind. Thus the cortex as such is only an organ for the mind to work through.

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The meachnics of the brain have been to a considerable extent understood on the basis of electronics. It has been observed by medical scientists, that there has been no serious organic change in the human brain during the last 30 thousand years or so. "The difference between modern and Paleolithic man is one of cerebral training and not of biological or anatomical advance. In later Paleolithic man there was already all the room for memories, all the associative capacity, the reasoning power, the ability to learn and the perceptive acuity of modern man". But the intellect has been growing because mind has been continually working through the brain creating newer and newer environments. There is mind in its full sense of the term only where there is a cortex like that of man. The world of values which mind seems to impose on cortical consciousness is not mere philosophical speculation. If the biological drives activating the brain-stem can be subject matter for scientific study, values—economic, aesthetic, social, ethical and religious—should be equally so for they motivate man at the conscious cortical level. Human nature and human behaviour should be understood only against the structure and functions of his world of values. It is here that man is distinctly human as different from the animals since the cerebral cortex allows the influence of mind. To explain all our social motives and social relationships in terms of primary organic needs controlled by the brain-stem, will not do justice to some of the finer pleasures and aesthetic enjoyments that we derive from life as a whole. Unless we eschew a good part of human values as we experience them day by day from the scientific study of psychology, we cannot explain human nature fully in terms of organic needs. What we call social motives at the human level have no physiological basis and the flexibility and variability observed in the expression of these social motives point to the fact that these belong to an entirely different level.

Psychology cannot and should not just ignore the experience of humanity. The creative outbursts which have continually raised humanity to great heights stimulating wonder and amazement in everyone suggest at any rate the influence of something different from electrochemical waves passing through the neuronal arcs or nets as the field theorists like to call it. Can reduction be applied here? May be, but still there will be something left unexplained. Boring in his powerful plea for a materialistic positive view of human behaviour says "My final word is this. Use those concepts of mind that promote science with the least awkwardness, the least circumlocation, but, when confusion or disagreement arises, try reducing the concepts to their operational equivalents. So often reduction shows you what to trust and where to become suspicious. The sensible thing is to work with a practical pluralism and to get your research done. If you get into trouble, then you can always retreat by reduction to the physical observational ultimates." One wonders, what really made Boring finish his learned article with these words. His mind perhaps does not allow him to negate it completely. Reductionism itself is made a weapon of retreat from the dark and as yet unfathomed depths of mind. We all have a need for a sense of security, even in our quest for knowledge. And that itself is one of the characteristics of mind. Introducing a collection of articles by Tolman, his colleagues say "As a behaviourist and as a "rat psychologist" it is Tolman's paradoxical contribution that he has returned man to psychology by insisting upon molar behaviourism, purposively organised as the unit of psychological analysis. He gave back to psychology its mind, lost through the mischief of a naive behaviourism, by inventing a method for inferring mental factors from behavioural events which has both scientific respectability and philosophic

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satisfaction". But mind you, this is said of a man like Tolman who in several places has declared that psychology seeks objectively statable laws and processes governing behaviour. Not that he is inconsistent. It is again the same unwillingness to go beyond a point when it comes to that. He summarises his position as follows. "There is, if you will still left in my universe a dichotomy, but it is a dichotomy not between physical entities and mental entities but between both of these as mere logical constructs, on the one hand, and immediate experience as the actually given, rich qualities, diffuse matrix from which both sciences are evolved, on the other. The purpose of science, of psychology as well as of physics, is not to describe and relieve experience but merely to explain it,—to help in predicting and controlling or to use Professor Pepper's term, to give map accounts of it. My dichotomy will be between reality and its maps and not between two types of reality". And he chooses to be content with maps, leaving the reality to the philosopher and the fact to the common man.

So far I have only tried to pick some holes in the promises and hopes held out by some of these scientists, indicating some positive leads here and there. It is not easy with our present state of knowledge to formulate any definite concept of mind that will be generally acceptable. Any such concept must be functionally related to three closely related disciplines (1) It must be related to life or life energy and hence Biology. Mind as we know it is connected with life, though we cannot equate the two (2) It is related to the cerebral cortex and hence to physiology, particularly neurophysiology. (3) It is related to behaviour particularly at the human level since the human being is predominantly a cortical animal. Hence, the concept of mind is directly and intimately concerned with psychology. The first two disciplines fought shy of this concept for their own reasons. Preoccupied with the doctrine of evolution and emphasising the emergence of complicated forms of structure in the struggle for survival, biologists are only now beginning to take the concept of life seriously. Copying the analytical methods of chemistry and physics, psychology also for a long time was fascinated by the anatomical approach which was tangible and objective enough. As a result psychologists also felt insufficient to pursue a study of this concept. Any excuse seems to have been sufficient to hand over the problem to the philosopher. As Cohen points out Freud also at first attempted a biochemical and neurophysiological reduction, but soon abandoned it. Later he developed his system of pure psychology with the basic belief that the study of the mind must be entirely detached from the anatomical study of the brain.

We said that mind functions through the cerebral cortex. But this does not mean that the brain-stem is completely left out. It has been reported by Penfield and others that continuous interference with the brain-stem can result in loss of consciousness. A constant and continued bombardment by impulses from the diencephalon is necessary to keep the cortex active. In fact, we should expect a secondary and indirect connection between mind and the diencephalon since mind is connected with life. Yet, the cortex is kept active not by the impulses from the brain-stem alone. A certain level of activity of the brain is necessary before liaison with mind is possible. This is demonstrated by the electroencephalogram. This activity is mainly caused by a generation of impulses in the cortical neurones themselves. Neurophysiologists refer to them as the spontaneous potentials of the cerebral cortex. These considerations and the neurlogical basis of memory as suggested by Lashley

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and Eccles "give an account of the specific events in the brain which are linked with specific states in the mind, but say nothing concerning the 'how' of that linkage."

The concept of mind should also be related to what we understand by the term 'self' or individual self. According to behaviourists 'The self is most commonly used as a hypothetical cause of action'. One may be prepared to consider other peoples' selves as hypothetical causes of action or as functionally unified systems of responses'. But I cannot agree that my self is nothing but a unified system of responses. For one thing, I must be sure of the unifying force. Further, my persisting hopes, aspirations, dissatisfactions and tensions all make me aware that there is no unified system at all. If anything there is continual disruption, breakdown, and purposeful effort at going towards some goal. Behaviourists may try to exhaust the list of variables of which behaviour is a function. But the most important and effective variable in human behaviour is the self itself. The self is thus a real entity, on its own right, growing and developing and seeking some kind of a goal which, perhaps for want of a better term, we call self-fulfilment.

It is not to make matters more complicated that I have brought in this concept of self at this stage. The trio, mind, brain and self, seem to be inter-related factual entities. Self emerges because of the liaison of mind with the brain. And the brain must be active and alive for this liaison to be possible. Any living organism has contacts and enters into liaison with the outside world and the energy-systems therein. Is it possible then, that an individual brain on reaching certain activity level becomes sensitive to mind energy? Is it possible that through this alliance consciousness and self or rather the self-conscious self emerges? Is it possible that the empirical individual mind thereafter gets so much entangled with the experiencing self that there is a definite process of individuation admitting all possibilities of uniformity and at the same time, the widest of individual difference. Cold logic is universal and prejudices are individualistic. Yet both are facts in life. One whose brain is thoroughly damaged will have neither logic nor prejudices. To some extent, creation also resembles this position. At the individual level mind and self interact because they get involved with each other. An individual's mind will depend on the brain and the self that has emerged. The brain becomes a super-sense organ sensitive to mind. Here, one feels that many of the thought products available in our philosophy should be studied seriously by psychologists. The data for psychology need not necessarily be confined to the right and left turns of the rat in a maze simply because we can count them more accurately. These thought products should be much more prized data for our study. I do not for a moment believe that I have suggested any new theory or concept of mind. I am intensely anxious that all students of psychology in this country should at least confront themselves with some of these fundamental and theoretical problems connected with our subject. The two points suggested are (1) that mind is an entity and (2) that it is a legitimate problem for study in psychology. And all I hope to have done in this paper is to disturb the tendency of some psychologists to take seriously even now, the false hopes raised by electronic brains and neurophysiology when they were themselves not much developed. If we do not at least question these hopes we will be in the words of Sir Russell Brain making our living by expounding the non-existence of our own minds.

Thank you,

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SECTION OF ENGINEERING AND METALLURGY

President :—V. CADAMBE, F.I.M. (London), M.I.Mech.E. (London.), M.I.E., F.N.I.

PRESIDENTIAL ADDRESS

ENGINEERING RESEARCH & DEVELOPMENT

LADIES AND GENTLEMEN,

I must express my sincere thanks to you all for having elected me to the office of the President of the Engineering and Metallurgy section of the 49th Session of the Indian Science Congress Association at Cuttack. It is indeed not only a great honour but also a great previlege bestowed on me though I am fully conscious of my limitations and shortcomings. All the same, I am sure that I shall be enjoying your confidence and kind co-operation in the discharge of my responsibilities. As one who has humbly toiled in the field of Industry, Education and Research for nearly thirty years, I have chosen Engineering Research & Development as the subject of my discourse. In the short time at my disposal I shall endeavour to review briefly the progress achieved so far in the country since independence in this direction. In the preparation of this address, I have drawn freely from several journals, periodicals and Government reports besides from my own previous publications. I, therefore, wish to express my grateful acknowledgment to the various authors on this subject though I have not made any specific reference to individual publications or authors.

INDUSTRIAL POLICY

It is common knowledge that Industrial and Technological Research in any country bears close relation to the pattern of Industrial Development, and again, the development of Industries depends upon the Industrial Policy of the country. As far as India is concerned, the Industrial Policy Resolution of 1948 adopted by the Government of India classifies Indian Industries under three categories :

"The first includes the manufacture of arms and amunition, the production and utilisation of atomic energy, river valley projects and the railways, which are State monopolies. The second comprises of iron and steel, aircraft, telephone, telegraph and wireless, ship-building and mineral oil industries. These are declared to be the responsibility of the State. The existing undertakings in this sector are to continue in the hands of private owners for at least ten years, but the initiative for their future development would lie with the State. The third category, consisting of eighteen industries, such as textiles, jute, woollens, leather, cement, sugar, tea, automobiles and tractors, prime movers, electrical engineering goods, machine tools, non-ferrous metals are to be the responsibility of private

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enterprise. These industries are, however, to be subject to central regulation and control."

Against this background, the Industrial and Technological Research in our country will have to be initiated and sponsored by the Government to a very large extent. This is a very important point we have to bear in mind.

Need for Research

The basic objective of our country's development is to improve the economic conditions of the masses and to provide them with opportunity to improve their conditions of living. The future standard of living in the country, therefore, depends upon the productivity of our Industries. One major factor will be the skill and power of our engineers in research and in the development and design of the necessary machinery and plant for all the various industries. India is at present dependent mainly on foreign imports for most of her requirements in basic materials and machinery required for the railways, ports and for many factories and workshops. More than all, the demands of our national security require highly mechanised units as the modern war is fought and won more and more with machines. Progress in all fields such as agriculture, textiles, electricals, locomotives, automobiles, ship-building, etc. depends on the availability of the suitable materials and necessary machinery.

To offer full employment in the country, large scale industrialisation is essential in the urban areas, and cottage and small-scale industries ; in their thousands and tens of thousands equipped with modern implements and machinery should exist throughout the country for the benefit of the rural population. We find that the problem of industrial advancement boils down to the capacity of the country to develop and process the basic materials from the indigenous resources, and to manufacture tools and machinery. This poses innumerable problems on the country for the solution of which *"Intensive Research"* in all branches of engineering *is the only answer.*

Lack of Progress in Engineering Research :

Engineering Research had not, hitherto, received the importance due to it with the result that industries based on Indian inventions are few. The industries which have been established in the country are based on imported plant and technology. The position has been summed up in the University Commission Report (1948) thus : "All constructive work for transportation, communication and industry, both civil and defence, design and consultation, and research needed for them were carried out abroad and the Indian engineers were employed in junior posts to supervise the construction and execution of projects or as maintenence and operation engineers under the supervision of foreign engineers."

What is Engineering Research ?

The word research means 'the quest of truth' or 'search for new knowledge.' It is impersonal in its aims and ideals. One who is engaged in research is free to follow his own intellectual pursuit without any external programme or direction. The outcome of such an effort is an addition to the knowledge and understanding of some natural phenomenon,

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irrespective of its usability or unsefulness. This method of probing into the mysteries of nature constitutes pure or fundamental or basic research.

Basic research is a necessary foundation for technical advance, but fundamental discoveries do not automatically give rise to usable products. The discovery of the fissionability of uranium did not in itself produce an atom bomb. For obtaining practical benefits from these fundamental discoveries, additional work in the form of applied research, engineering development, and production with the aid of technical services are necessary. These activities are generally grouped under the title 'technology and engineering.'

Engineering has been defined as 'the art of directing knowledge of the physical science towards useful ends.' Gano Dunn, the distinguished engineer, defines it as the 'art of the economic application of sciences to social purposes.' Still another definition widely quoted is, 'Engineering is the art of directing men and controlling the forces and materials of nature for the benefit of human race.' All these three definitions suggest that engineering is an 'art', namely the art of directing, applying or controlling something for the benefit of mankind. 'Art' connotes 'skill', and to acquire skill in applying the principles of physical sciences for human needs calls for further knowledge obtainable only through research. The social aspect is implicit in the concept of engineering and it has no value unless it is directed towards furthering human ends. The term 'engineering research' may, therefore, be used to describe any investigation undertaken to harness the forces of nature for the benefit of mankind. According to the definition formulated by the National Research Council of America, engineering Research is 'the endeavour to learn how to apply scientific facts to the service of mankind.'

Development

Engineering progress depends upon a continuous flow of new knowledge and its effective application. In earlier days, this new knowledge was derived from experience gained in engineering practice. But nowadays it is principally the outcome of organized scientific research. Effective application of this knowledge depends to a great extent on the ability, training and experience of all personnel engaged in many phases of engineering practice.

Between the birth of an idea which is the starting point of new knowledge and its application to purpose there are fairly well defined stages. The first of these is fundamental or basic research which may suggest the possibility of industrial application, and the scientist in industry experimentally explores this possibility. His work may lead to production under laboratory conditions of a new or improved material or point the way to a new process to evaluate the practical possibility. It is necessary to study the laboratory process further on a pilot plant or on a small scale manufacturing basis. This is known as developmental research. If the results of developmental research are sufficiently promising to proceed to full scale production, the research engineer translates the experience and methods into a routine process of manufacture.

Similar stages may be seen to exist in the development, design and manufacture of machinery. Keeping before him the new idea born of fundamental research, the engineer has to explore its usefulness by constructing representative models and studying their performance under various conditions. He then has to complete the preliminary design and make a 'mock-up' of the machine as in the case of an aeroplane. The first

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machine usually called the prototype is thereafter constructed and put to a series of rigorous tests so as to conform to the required standards and specifications. The last stage of the development consists in rigging up tooling for the mass production of the finished products.

It is difficult in most phases of engineering to separate research from the developmental processes which make use of new scientific data ; hence such research and development should proceed hand in hand, with the closest cooperation between the personnel engaged in these two activities. Research has now institutionalized invention and the responsibility for new technical ideas has passed from the individual inventor to a team of scientists working in organized laboratories.

In most countries, universities provide facilities for fundamental research, and the scientists in industry have to seek the help of the universities to obtain this new knowledge. With the advent of scientific methods in engineering technique or design, it has become necessary for the engineering profession itself to dig out and uncover much of the basic scientific knowledge essential for further development. The basic engineering sciences, such as mechanics of materials, fluid mechanics, soil mechanics, thermodynamics, and other branches or applied science are built up almost entirely through research, study and contribution of engineers who, in the majority of cases are from the universities.

In engineering research, the most important economic factor is the saving of time. This applies to the facilities to be provided to the research worker by way of tools, materials and equipment to suit his requirements, whereby considerable time can be saved.

Time-Lag

Another important factor is the time-lag between discovery and its use. It is here that engineering research has to play an important role in filling the gap. There are actually two stages, one between discovery and application, and the other from application to actual use. The first of these is the gap in basic scientific knowledge which occurs because workers in pure science do not cover the entire area of required scientific knowledge. The technical sciences endeavour to fill this gap in their respective fields, but the second gap can be bridged only by the engineer. It falls to his domain to reduce this period to an absolute minimum. In doing so, sound judgement is required as to the magnitude of the research programme necessary to bring it to the developmental stage. The importance of this plan was emphasized in wartime, when it was cut down to an incredibly short period under the impact of war when finance was a consideration of secondary importance.

In the more leisurely days of the last century and up to the time of the First World War, there was often a long delay between the end of a basic research study and the report of the results or between the report and the use of the findings. Thus Faraday's laws of electromagnetic induction, formulated in 1831, found practical application in the design of a dynamo for generation of power by Edison only in 1881. In the field of biology, the theory of inheritance was applied to hybrid corn in 1939 in the U.S.A., though Gregor Mendel, father of modern genetics, formulated his theory of inheritance in 1866. Detection of Maxwell's electromagnetic waves by Hertz in 1887 in Germany and the transmission of the first trans-Atlantic signal by Marconi in 1898, the making of diode valves by Fleming in 1904 in England, and the triode valve by de Forest in the U.S.A. in 1906, are further examples. In modern times, this time lag is

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dwindling fast. The first nuclear fission was reported in 1939 in Germany by Otto Hahn and F. Strassman and the first atom bomb was exploded soon afterwards in 1945. During the period 1946-48, in the field of aerodynamics, hungry engineers in fact were lined up back of the scientists, waiting for facts and laws that governed flight at supersonic speeds. The leaders of industry in Western countries have now realized that applied research is rapidly overtaking basic research ; though such a situation may not arise in the foreseeable future in India, it is as well to recognize the importance of this factor at the present moment when we are on the threshold of organizing our research.

Research Begets Research

In engineering research, it always happens that while developing a process, the research worker may come across an entirely new and separate problem. This means, research begets research. Its application may well be the starting point for further research. The development of the gas turbine, for example, called for highly refractory materials in the production of which entirely new research problems arose and the solution of these again posed new problems which required further research. Here again, judgement was needed to specify limits on the extent of money, time and labour on research so as to ensure a reasonable economic balance between expenditure and ultimate commercial return.

Teamwork

The days of the individual research worker are gone. New materials and techniques involve the use of such complicated machinery and instruments that it will be almost impossible for a single research worker to independently equip himself with all of them. It may be true that a falling apple had at one time inspired the greatest of epoch making scientific discoveries, but the modern research worker has to lose himself in a maze of experimental set-ups before he can hope to make any substantial contribution to material advances or to technological research. And all this equipment and up-to-date facilities can be provided only by institutions with large financial backing. In short, industrial research is no longer in the reach of an individual and lone worker but has been passed on to teams of workers in large institutions.

Engineering research calls for teamwork and coordination of effort between the scientist and the engineer. The Science of engineering is fast developing. The technique of today is often unsuitable for application tomorrow. It is, therefore, all the more necessary for an engineer to keep an open mind and train himself to work in a team. No single engineer or scientist or organization can claim to have all the reservoirs of available knowledge.

Research—A Gamble and Investment

If research is to bear fruit, it is important that it should be properly directed as there is no field, in which money can be spent wtihout justifiable results as research, if not properly directed. It is equally true that in no other field, investments pays such high dividends as in research, if properly directed. Research is highly competitive, the competition being in ideas. Every idea must compete with all other ideas in the market

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place of science and engineering. No one can tell which idea will stand up under severe testing in the laboratory or in practice.

E.I. du Pont de Nemours & Co. of America, describes research as the game of chance and has told its stock-holders how it turns this research gamble into sound business investment. "Comparisons with games of chance, however, can be carried only so far in describing the risks of research In the former, a mathematician with a slide rule can figure the odds ahead of time. Not so in research. There the odds are set by a combination of factors. The wisdom of management, the inventive genius of the scientists, the dollars and facilities available for research. There's no advance gurantee, then that 1 in 20 or even 1 in 40 projects will pay off. Rather, the test of successful research is management's ability to fashion odds under which winnings will exceed losses by a profitable margin." This company has found that it invests about 4 dollars in research for every dollar spent on successful projects. The good idea pays not only for the whole research programme, but for development costs and plant and equipment to produce the new goods on which the company's continuing welfare depends.

Brief History of Engineering Research

ORGANIZED engineering research in India has only a brief history. Before the turn of the century scientific investigations were confined to such goverenment services geological survey, botanical survey and the departments of agriculture and meteorology.

The establishment of the hydrodynamics research station at Poona in 1916, as a result of work by a few engineers engaged in *ad hoc* research problems in irrigation and hydraulics, was the first step in the evolution of enegineering research ; immediately after the 1914-18 war, the Imperial Council of Agricultural Research was established ; formation of commodity committees and technical laboratories for cotton, jute, lac etc. followed. Gradually more facilities were provided in universities and colleges for study and research in science and engineering, but still the only institution in the country devoted exclusively to higher studies and research in pure and applied science was the Indian Institute of Science founded at Bangalore by J. N. Tata in 1911. In the following years various research committees evolved, but it was not until 1935 that the Government of India, after great deliberation, constituted the Industrial Research Bureau to act as a central organization and coordinate them.

Council of Scientific & Industrial Research

The 1939-45 war brought about a great increase in technological research. Owing to difficulties in importing foods from overseas it became necessary to mobilize all indigenous resources for the production of war essentials. One important step was the formation of the Board of Scientific and Industrial Research to exploit the scientific resources of the country. This board was succeeded in 1942 by an autonomous body, the Council of Scientific and Industrial Research (C.S.I.R.), with wide powers to finance and organize industrial research in the country. The Council set up a large number of technical and research committees, and brought together leaders of science and industry to plan and promote research programmes in many fields of applied science. It provided equipment and funds for this work to be carried out in universities, colleges and research organizations.

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After Independence, a chain of nearly thirty National Laboratories was set up in different fields in the various parts of the country. Of these, two deal mainly with fundamental research—The National Physical Laboratory at New Delhi and the National Chemical Laboratory at Poona while eight Laboratories devote their attention to Engineering Research and the rest to Technological Research in their respective fields.

The Council has also been paying attention to the urgent need for integration and co-ordination of engineering research in the country. A number of research committees have been set up for various branches of engineering ; these committees survey various fields of engineering research, sponsor research schems in institutions, take care of border-line subjects, and suggest ways and means of furthering research for industry.

Engineering Colleges & Institutions

Research in Engineering Colleges is only a post-war development. Prior to this, there was no tradition of research in any of these institutions due to various historical reasons. Now there are about 25 Institutions offering post-graduate courses in Engineering while about a hundred of them offer courses upto degree level in Engineering. The Ministry of Education which exercises genral control over the pattern of education has recognised the All India Council for Technical Education for the promotion of technical training in the country. On the recommendation of this committee, four higher technological institutions on the model of Massachusetts Institute of Technology (U.S.A.) are founded in the Eastern, Western, Northern and Southern (Kharagpur, Bombay, Kanpur and Madras) regions. Besides there are a number of regional engineering colleges established under the grant of the Centre. The out-turn of engineering graduates is of the order of 5000 per annum during the 2nd Plan period and in the 3rd Plan period it is hoped to turn out 50,000 graduates by 1966. There is provision for training an equal number of Diploma holders and double the number of artisans and craftsmen.

RESEARCH AND DEVELOPMENT UNDER GOVERNMENT

In the following paragraphs are summarised very briefly research and development undertaken by the various Government departments.

Atomic Energy Commission

The Atomic Energy Commission was set up with the objectives of developing atomic energy as a source of direct heat for industry on the one hand and to develop its multifarious uses in agriculture, biology, industry and medicine mainly as a result of the production of radioactive isotopes on the other. With these in view, the Atomic Energy Establishment at Trombay have constructed three reactors "APSARA", "ZERLINA" and "CIR". A power reactor is to be constructed at Tarapur about 60 miles north of Bombay with an installed capacity of 300,000 kw.

Commerce and Industry

1. The Development Wing of the Ministry has under its purview several Directorates for Industrial advancement. Direcetorates for Tools, Industrial Machinery, Standing Metric Committee, I.C. Engines and Allied

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Industries, Light Mechanical Engineering Industries, Heavy Mechanical Engineering Industries, Metals, Electrical and Instruments each focussing its attention on the relevant discipline.

2. Cottage industries board, to advise and assist the Government in the organization and development of cottage and small scale industries.

3. Patents Advisory Committee.

4. Hand-loom Development Board.

5. Industrial Finance Corporation.

6. Small Scale Industries Board, on the advice of the International team under the Ford Foundation scheme.

7. Industrial Development Corporation, to study the development of new industries in private sectors.

The Indian Standards Institution functions under the aegis of this Ministry.

In addition to the above, the State-owned and State managed industries, such as Feretilizer Factories, Hindusthan Ship Building Yard, Cables Factory, Machine Tool Factory and the National Instruments Factory, are functioning under this Ministry.

Communication

The Indian Telegraph Department has established workshops at Bombay, Calcutta and Bangalore. A training centre for telecommunication engineers has been set up in Jubbulpore. Research on *ad hoc* problems connected with telecommunication engineering is carried out at Bombay. The Indian Telephone Industries Ltd., Bangalore, refers problems relating to telephones and line equipment to this laboratory.

A Research and Development Directorate has been set up under the Directorate General of Civil Aviation. This organisation is concerned with type certification and maintenance of aircraft. It is also engaged in developing standard specifications for aircraft materials.

The Indian Meteorological Department supplies weather data required for aviation services, navy and mercantile shipping. The scientific functions of the department relate to terrestrial magnetism, atmospheric electricity, seismology, astronomy and astrophysics, and agricultural meteorology. The Department also collects data on hydro-meteorology, a subject which has attained importance for the development of river valley projects.

Defence

The Defence Science Organisation established in 1948 is concerned mainly with the application of scientific knowledge for the design, development and production of stores and equipment for the Defence Services. It undertakes research in scientific problems referred to it by the three services and secures their integration. Research units are attached to the Military Engineering Services at Poona, the Naval Research Centre at Bombay and Cochin, Technical Development Establishments at Kanpur, Poona, Ahmednagar and Ishapur, Dehra Dun, Bangalore and the Air Force Headquarters at Delhi. The Institute of Armament Studies was set up in Kirkee in 1953. Operational research and research on problems connected with armaments, ballistics, thermodynamics of explosives, etc. are engaging the attention of the Defence Science Organization.

The Hindusthan Aircraft Factory Ltd., Bangalore and the Machine Tool Prototpye Factory, Ambarnath, a chain of ordnance factories and the Bharat Electronics at Jalahalli are functioning under the Defence Ministry.

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Food and Agriculture

The Forest Research Institute, Dehra Dun, conducts research on the utilization of timber as constructional material.

The Indian Agricultural Research Institute has a separate Division on Agricultural Engineering which is concerned with the design and development of implements and equipment for agricultural operations.

The Central Tractor Organization functions under the Ministry of Food and Agriculture.

Broadcasting

All India Radio has a research organization dealing with broadcasting problems such as development of new equipment for more efficient broadcasting, acoustics of studio and ionospheric studies. They have widened their activities recently by introducing Television in the country and experimenting in their efforts to establish an Audio-visual education programme in schools.

Irrigation and Power

The Central Water and Power Commission (C.W. & P.C.) is responsible for initiating, promoting and coordinating multipurpose irrigation and power projects in the country. The Central Water and Power Research Station at Poona has been expanded to cope with the heavy work connected with the several projects now under execution in the country. There are, besides, nineteen regional hydraulic and irrigation laboratories engaged in problems of research and development. The contributions made by the various laboratories to irrigation research have been significant and outstanding.

Iron and Steel

There are three large steel plants at Rourkela, Bhilai & Durgapur and coal washeries set up under the Second Five Year Plan and the fourth one at Bokharo is taken up using Indian talent in designing various components and units. It is the largest public undertaking with a capital outlay of 800 to 900 crores of rupees. Each has got its own research and control laboratory.

Natural Resources and Scientific Research

The Council of Scientific and Industrial Research functions under the aegis of this Ministry. The official surveys—the Geological Survey of India, the Zoological Survey of India, the Botanical Survey of India and the Survey of India etc., functioning under this Ministry.

Railways

The Railway Board has established a research centre at Lucknow for the investigation of problems referred to it by the railway workshops and the Central Standards Office. The factories at Chittaranjan and Perambur, producing locomotives and carriages respectively, present several engineering problems for investigation and research.

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Transport

The Roads Organization functioning under the Ministry of Transport is concerned wit problems on road development and road materials, and highway and bridge engineering. The Ministry is also concerned with ports and harbours.

Works, Housing and Supply

The Central Public Works Department is concerned with the construction and maintenance of office buildings, residential accommodation for Government servants and air ports.

A National Committee for Cheap Housing has been set up to examine the question of housing for low income groups. This may be linked up with Community Projects. Several problems in social engineering, cottage and small-scale industries, transport and communication in rural areas, and agricultural engineering present themselves for investigation.

Research in Industry

Several industries, e.g., cotton textiles, jute, wool, leather, cement, sugar, tea, automobiles and tractors, iron and steel and machine tools and non-ferrous metals, have recognised the importance of research, and some of them have established research units for investigating *ad hoc* problems. The Tata Iron and Steel works was the first in the country to maintain a control Laboratory ; a few more like the Shri Ram Institute for Industrial Research, Delhi, Ahmedabad Textile Industries Research Association, Ahemadabad, Birla Textile Research Laboratory, Bhiwani, the Textile Research Association Laboratories, Bombay & Coimbatore are functioning on a cooperative basis.

The Silk Board is focussing its attention on methods to increase yield of mulberry per acre, to create a sound seed organisation and to replace a large number of traditional charkhas by cottage basins and so to reduce the cost of production of raw silk.

Standardization and Testing

The Indian Standards Institution established in 1947 is responsible for the promotion of standardization, quality control, and simplification in industry and commerce. In its work, the I.S.I. secures general agreement and covers all interests concerned, namely, the consumer, producer, Government, technology and trade, and thus has the backing and authority necessary for acceptance of its specifications as national standards. During the past 15 years, the Indian Standards Institution has brought out over 900 standards on different items. All the testing establishments in the country and research laboratories, both in public and private sectors, help and cooperate with the I.S.I. in its work.

Research Utilization

In recent years an organization called National Research Development Corporation (N.R.D.C.) has been established with the object of developing and exploiting for profit or otherwise all patentable and also non-patentable inventions. The Corporation undertakes pilot plant investigations and takes such steps as necessary to promote the advancement of Indian industries.

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Library and Information Service

At present there is no central library and information service covering all branches of engineering ; however, the library of the Central Board of Irrigation and Power, considered one of the best in South-East Asia, meets the needs not only in its particular field but in other subjects to a certain extent. It has all the modern facilities such as microfilming, photostating, etc. Libraries of the various educational and other research institutions also fulfill the same objectives to a limited extent. The establishment of INSDOC by the Central Government at the N.P.L is a great step towards promoting the information service. With the help of this organization, it is now easy for a research worker in India to get any literature of information at a nominal cost.

Recommendations

There are several Survey Reports on Engineering Research published by various Agencies but the survey in all these reports reveals that considerable research work has been done in the field of irrigation engineering in which India leads the world. In civil engineering, particularly in construction techniques and materials, there has been no progress worth mentioning. On the whole, therefore, very little engineering research is being done and the number of research workers available is also extremely small in the country having regard to its size, population, and natural resources.

With a view to ensuring overall progress in engineering research and development in the country, a few imoprtant measures are suggested under broad heads, namely.

1. Personnel
2. Materials
3. Equipment, Funds etc.

Personnel

On no other aspect does progress in research depend so much as on the right type of personnel. The need for training and equipping first class research engineers cannot be over-emphasized. Out of the five thousand graduates passing out of the colleges every year, only a small percentage is suitable for research. Besides, most of these graduates look upon some executive job as their ultimate goal. Our industries have also started offering attractive terms and conditions of service for qualified engineers. Therefore, they do not think in terms of research as a profession for life. Some of them may of course be inclined to take up research jobs as a sort of stop-gap arrangement. This situation is partly due to economic conditions, and partly due to the pattern of training imparted.

The leaders of education, industry and Government in the country have already taken steps to remedy these defects and have formulated suitable plans to meet the shortage of this class of engineers. With this end in view, the four Higher Technological Institutes in Kharagpur, Bombay, Madras and Kanpur have been established, and post-graduate training in several branches of engineering in the Indian Institute of Science and eighteen othr colleges has also been instituted.

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It is absolutely necessary to screen the research talent in the country and build up a pool of such research workers to man national laboratories and other institutions. The basis for selection should be intellectual acumen, creative ability, independent thinking, originality, good foundation in fundamental sciences, and aptitude for invention and research. It may perhaps be necessary to draw men with a sound background in fundamental sciences and give them an engineering bias before they are put on research work. Also, these people should be able to work in a team because collaboration between scientists and engineers is necessary. In America, such men form the bulk of research engineers, and in India this group is totally absent.

There is a tendency among engineering graduates to migrate to administrative posts which are the best paid jobs in the country with enormous status attached to them. Particularly, the first class graduates who come out of the engineering colleges think only in terms of positions in the All India Engineering Services such as the Railways, the Posts and Telegraphs Department etc. which are more or less constituted on the same lines as the administrative posts, but the research jobs are left un filled because they are not only low paid but also there is no status for the research workers as exists in other countries like England, America, Germany and elsewhere. To check this tendency for migration, parity of service conditions should be assured between research jobs and administrative posts.

Engineering study in India is of four years duration in the case of qualified Inter-Science and five years for Higher Secondary passed candidates. But in many cases, graduates in mathematics, physics and chemistry also apply for admission. Usually most of the engineers upon graduation find suitable jobs and the best ones get good posts in Government or Industry. If the engineering graduates have to return to the colleges for post-graduate training and research, it may require between two to four years or even more to get a Master's or a Doctor's degree because research in engineering is much more complicated and calls for definite results.

The cost of engineering education has become very high in the country and there is no means for a student either to work his way through college or to meet part of his expenses by his own earnings. Therefore, the students are very anxious to start earning soon after graduation. The post-graduate training should not only be self-supporting by making students work part-time in the colleges but also should promise a higher start in emoluments than what is offered to ordinary engineering graduates. The post-graduate training should be equated to four of five years of experience while considering initial remunerations. This aspect should receive the attention of the leaders of industry, education and Government if good engineering graduates are to be attracted to post-graduate studies or research.

It is not enough if there are only research workers but they must always be assisted by a team of designers to translate their ideas into reality and to give practical shape in designing and developing precision machinery and instruments often required for experimental work. Also, the research team should be supported by a large number of technicians and artisans with facilities of modern workshops and well equipped laboratories. In fact, the answer to future progress in this country lies in men, men with training and experience, men of creative ability and independent thinking, and men of vision and sound judgement—in their hands rests the prosperity of the country.

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Materials

The mineral resources of India are not large when compared to her size and population but even those available are not fully explored and exploited. Only items like coal, mica, building materials (including constructional stones, limestone, etc.), salt, mineral oils (petroleum), manganese ore, iron ore, copper ore, and ilmenite are produced in quantities to be of real importance to industry and other sectors of economy. Of these, mica, manganese ore, and ilmenite are wholly or largely exported. The important non-ferrous metals are either not produced in India at all or their production is insignificant. Only a small percentage of India's requirements in mineral oils is produced in the country. Sufficient quantities of industrial clay, bauxite, chromite, natural abrasives, magnetite, felspar, dolomite, phosphate, vanadium, titanium etc. are, however, available. But these ores are not advantageously distributed for industrial exploitation and, consequently, the coordination of their production and distribution has become difficult and costly. India lacks in base metals, her own deposits of tin, lead, copper and zinc being quite low. Minerals of strategic and defence importance are adequate but the country is seriously deficient in munition metals like tungsten, tin, lead, zinc and mercury, and in graphite and liquid fuels. But the basic metals, iron, manganese, aluminium, magnesium and chromium are available in abundance. India has also large deposits of atomic minerals ; a factory has been set up at Alwaye to process monazite sands and another at Trombay to extract uranium and thorium from the waste eliminated by the plant at Alwaye.

In order that Indian engineering industries may progress rapidly, the essential materials that are urgently needed for industrialization should be developed in the country. Important among these are high speed tool steel, stainless steel, die steel, spring steel, nickel-chrome steel, high grade steel to withstand high temperatures and pressures, synthetic high speed cutting materials like stellite, carboloy, etc., light and heavy alloys such as duralumin, phosphor-bronze and silver solder ; non-ferrous metals like titanium, manganese, aluminium, lead, tin, nickel, copper and the like for evolving suitable alloys ; non-metallic materials such as mica, plastics, bearing jewels, optical glass, piezo-electric quartz, and others. Though indigenous resources are available for the production of many of these items in the country, much progress has not been achieved in this respect for want of the required technical knowledge. These problems are interrelated to the problems connected with the evolution of suitable designs for machine tools and other machinery, and attempts should be made to manufacture at least a few of them in the country.

Equipment and Funds

Engineering research needs elaborate and costly equipment in the form of apparatus, precision instruments, and highly involved measuring techniques. Moreover, each branch of engineering has become so highly specialized that for the solution of a problem in a particular branch, separate experimental set-up and a variety of measuring instruments are required which may not be wholly or partly used for analysis of a problem in another field. This intricate nature of engineering research has resulted in the demand for huge sums of money to be invested on apparatus and equipment which call for constant change, improvement or replacement.

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International comparisons of research activities with ours will no doubt be very helpful and educative in planning our future research programme. The budget figures are mentioned merely to show the importance and status attached to research in other countries but should not be construed as the author's recommendations to our Government for alloting such budgets from our meagre resources.

In the U.S.A. about Rs. 6000 crores and in U.K. about rupees 900 crores are spent annually on Scientific and Industrial Research ; for the entire third plan period in our country, a sum of rupees 130 crores is earmarked for basic and applied research.

During the Third Plan Period about Rs. 10,000 crores are provided to speed up industrialization in the country, out of which Rs. 4300 crores are proposed to be spent on industries in the private sector. It should also be remembered that the country is spending over Rs. 400 crores every year on the import of finished and manufactured articles, machinery, plant and equipment for our defence requirements, Railways, Posts and Telegraphs, and others both in public and private sectors. A good deal of research and development work is required in order to keep at least a part of this amount in the country by meeting the requirements from indigenous resources and thus reducing such imports to the barest minimum.

In view of huge investments quoted above and of the continuous drain from the country on imports, it is highly discouraging to find that our industries have not made any concentrated efforts to undertake research on an appreciable scale. The pattern of research and the future trend in the industrial advancement depend upon the industrial policy of the country. Unless this policy is so shaped and re-oriented as to infuse confindence among the industrialists, sufficient initiative and enthusiasm will not be forthcoming from them to start industries and organize industrial research on a large scale. It is true that research in modern times involves very large amounts of money, time and energy, and more than all, trained technical personnel and special materials and equipment ; however, the responsibility of financing industrial research should not be entirely left to State initiative but should be shared by the industries themselves if any national plan for economic wellbeing of the country is to materialise.

Design and Development

It is only in the development and manufacture of machinery and industrial plant and equipment that our engineers will find full scope for research and inventions, but our industries have not as yet grown to the stage of sponsoring new designs and development of machines or plant or equipment which require for their successful execution a large complement of trained designers, research engineers, production planners, and other supporting staff. This class of engineer-cum-scientists is totally absent in India and, therefore, there is great need to build it up if our country aspires to be on a par with other countries in this respect.

India has not caught up with industrialization while foreign countries have been progressively advancing in industries for over two centuries. It is not profitable to start evolving new machines and equipment from scratch as it takes enormous time and money before a suitable design is evolved and its prototype tested for required standards and specifications. So, in the initial stages, it is always advantageous to buy a few designs from foreign countries on royalty basis and arrange for their production

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with suitable modifications. Side by side, a few important design projects in different industries such as machine tools, small tools, electrical machinery, aircraft, chemical plant, and electronic appliances may be sponsored in various private and public undertakings by the Government and all encouragement for their successful execution should be accorded.

Though in some cases these projects may not be successful, yet they give an opportunity to build teams of trained personnel to develop indigenous materials or find substitutes to evolve national standards and also inspire confidence in our engineers to take up such jobs in the country. Even in foreign countries, out of hundreds of designs evolved in the drawing Office, only one or two will have their prototypes built and perhaps only one may see the assembly line after repeatedly undergoing modifications and changes. It may also be mentioned that in the design of articles for civilian use, due attention should be paid to market and sales research, while in the case of defence requirements, the needs of service groups should be kept in view.

Industries, Technological Institutes and Government

Cooperation between universities and industries is essential for an integrated industrial development. Professors from engineering colleges should be invited by the industries to study their problems and render advice on development and modernization, while engineers from industry should be invited to colleges to give lectures to students on day-to-day problems and developments in the industrial sphere.

It may be stated that pure research in engineering will result only in theoretical abstractions, and unless industries are developed and new projects undertaken most researches may not find scope for application. Therefore, to ensure progress in engineering research all the three will have to play their proper role ; the Universities by supplying fundamental knowledge and trained personnel, industries by properly making use of the knowledge and personnel, and the Government by encouraging research and research workers.

Engineers and the future

About 85% of India's population of 440 millions (1961) live in rural areas and are mostly dependent on agriculture. While a greater part of this rural population has normal seasonal employment, the others are either under-employed or unemployed. The remaining 15% live in urban areas having opportunities to take advantage of modern ametities such as transport, housing, roads, and health facilities.

We have in our country about 40 thousand miles of railways, constituting the fourth largest system in the world. We have, on the one side, automobiles and trucks for road transportation, radios and radar, coastcraft and ocean going vessels, light and heavy aircraft for both civil and defence use, and many other things such as machinery, plant and equipment for industries—textiles, jute, sugar, cotton, chemicals and steel ; while, on the other side, we have a large percentage of people living under poor housing conditions, having no other form of transport than bullock carts, and still continuing to depend upon village blacksmiths, weavers, potters, carpenters and others for their daily necessities. The problem of bettering conditions in the rural areas calls for intensive research directed towards improvement in the methods of fabrication and production in village industries by using modern machines and tools. At the

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same time, attention should be paid to the building of cheap houses using indigenous materials to suit our climatic conditions and the social needs of Indian ways of living and also to village irrigation, sanitation, roads, transport, etc.

We cannot afford to ignore mechanization because industries like aircraft, locomotives, shipbuilding, electrical machinery and heavy machines etc. should be able to design and produce goods in the country according to latest developments. Besides, our railways, radios and radar, telephones, telegraphs, aircraft, ships, etc. all need replacement. We cannot also ignore the impact on India of the industrial advances of the west. We have our Army, Navy and Air Force which will require highly mechanized units and up-to-date equipment, all designed and built in the country itself. So, the solution lies not only in rationalizing and modernizing the old and obsolescent methods and techniques in use in the existing industries, but also in the development of new, heavy and large scale industries to produce all our requirements within the country itself. Our leaders have envisaged a number of schemes in the Third Five-Year Plan to speed up industrialization but it is the responsibility of the engineers to translate all the schemes into reality, and unless full confidence is reposed in them the country cannot progress much technologically and industrially. It is now recognized in all countries of the world that in peace scientists and engineers are the creators of wealth, and in war they are the indispensable warriors and the laboratories and the industries become the first line of defence. How far we should industrialise intensively in certain fields and to what extent we have to lay emphasis on cottage and small scale industries for the common good of the country at large, should be a matter for decision at the higher level. The importance of engineering research towards achieving this happy consummation cannot be over-estimated.

JAI HIND

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49TH INDIAN SCIENCE CONGRESS, CUTTACK, 1962

SECTION OF MATHEMATICS

PRESIDENT Dr. P. L. BHATNAGAR, M. Sc., D.Phil., D.Sc., F.N.I.

Abstracts

Theory of Numbers

1. On Some Properties of Partition

V. V. SUBRAHMANYA SASTRI, Tirupathi

The generating functions of $p\ (2n+l)$, $q\ (2n+l)$, $l = 0,\ 1$ are found in terms of $f(x) = \prod_{n=1}^{\alpha} (l-x^n) = \sum_{n=-\infty}^{n=\infty} (-1)^n\ x^{n/2}\ (3n+1)$, $p(n)$, $q(n)$ being the number of partitions of n into unrestricted and unequal parts respectively. Incidentally, some relations between $\sum_{n=0}^{\infty} p(2n)\ x^{2n}$, $\sum_{n=0}^{\infty} p(2n+1)\ x^{2n+1}$, $\sum_{n=0}^{\infty} q(2n)\ x^{2n}$, $\sum_{n=0}^{\infty} q(2n+1)\ x^{2n+1}$ and $f(x)$ have been proved.

Next, the generating functions of $q(3n+l)$, $l = 0,1,2$ are found in the terms of $f(x)$ and $\psi_l(x) = w^{l-1} f(wx)\ f(wx^2) + w^{2(l-1)} \times f(w^2\ x) \times f(w^2x^2)$, w being an imaginary cube root of unity and $\psi_l(x)$ are expressed in terms of $\phi_1(x) = w^{l-1}\ \times f(wx) + w^{2(l-1)}$ $f(w^2x)$. Further some incidental relations between $\Sigma\ q(3n)x^{3n}$, $\Sigma\ q(3n+1)x^{3n+1}$, $\Sigma q(3n+2)x^{3n+2}\ f(x)$ and $\psi_l(x)$ have been proved.

Modern Algebra

2. Bounded Linear Operators in a Hilbert Space

S. K. SINGH, Dharwar

In this paper the algebraic structure of bounded linear operators are studied. Let H be a Hilbert space and let β be the set of all bounded linear operators defined on H into H. Then it is easy to verify that β forms a ring with identity under usual addition and multiplication of operators. Let α be a subset of β, define

$$\alpha_1 = \{\ T \in \beta : TS = ST \text{ for every } S \in \alpha\}$$

$$\alpha_k = \{\ T \in \beta : TS = ST \text{ for every } S \in \alpha_{k-1}\}$$

$$k \geqslant 1.$$

α will be called a commutative subset of β if $T_1\ T_2 = T_2\ T_1$ for every pair T_1, $T_2 \in \alpha$; and α will be called a Hermitian subset of β if all the operators in α are

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Hermitian (that is, when $T^* = T$ for every $T \varepsilon \alpha$ where T^* is the adjoint operator of T).

We prove the following theorems :

Theorem 1 (a) $\alpha_1 = \alpha_3$ for every $\alpha \subset \beta$

(b) $\alpha = \alpha_2$ if and only if $\alpha = r_1$ for some $r \subset \beta$

(c) α_1 is a subring of β.

Theorem 2(a) Let $\alpha \subset \beta$ then α is a commutative subset of β if and only $\alpha \subset \alpha_1$

(b) β is a commutative ring if and only if $\beta = \beta_1$.

Theorem 3 : If α is a Hermitian and commutative subset of β then α is a commutative subring of β.

Theorem 4 : If β is a division ring then β_1 is a field.

Theorem 5 : β will form a division ring if and only if

(i) there exists a positive number c such that $\| Th \| \geqslant c \| h \|$ for every vector $h \varepsilon H$ and every $T \varepsilon \beta$ and when

(ii) $\overline{T(H)} = H$.

where the closure is taken in the norm topology.

Set Theory

3. On Certain Property of Sets with Positive Measure

A. K. Mookhopadhyay, Calcutta and B. K. Lahiri, Burdwan

In this paper we prove the following theorem : If C be a closed set of positive measure contained in the open unit sphere in E_n (n-dimensional Euclidean space) and $\lambda_1, \lambda_2, \ldots \lambda_p$ be any p real numbers satisfying

$$1-\delta < \lambda_i \leqslant 1, \; i = 1, 2, \ldots\ldots p ;$$

δ (>0) depending on p,n and the measure of C, then the set of points ξ of C such that

$$\frac{\xi}{\lambda_i} \varepsilon C, \quad i = 1,2,\ldots,p$$

form a closed set of positive measure.

A result of the similar kind has been proved earlier by one of the authors (Lahiri, B. K. (1959), Bull. Cal. Math. Soc., 51), restricting the numbers $\lambda_1, \lambda_2, \ldots \lambda_p$ to range in some suitable right neighbourhood [one sided closed] of 1.

4. On the Construction of Some SD-sets

N. C. Bose Majumder, Calcutta

This author has shown (1960) that Cantor set C is, an SD-set (called here, 'δ' property) [i.e., a set E whose distance set fills an interval about origin, of length = diameter of E], a symmetric set (called here, 'δ' property) [i.e., there is a point $y \varepsilon E$ corresponding to any given point $x \varepsilon E$, such that $x+y = a+b$, where E $[a,b]$

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and $a \varepsilon E$, $b \varepsilon E$], and has the property (called here, 'μ' property), that each point of the interval in which E is defined, is midway between a pair of points of E.

We have shown (1960), that (i) if a set E possesses σ and μ, it must possess δ; (ii) if E possesses σ and δ, it must possess μ. We now show that (iii) if E possesses μ and δ, it does not necessarily possess σ.

Moreover, we have constructed here a family of symmetric sets and tested them by the above theorems (i and ii) for *SD*-sets. We have shown in this paper that the set E of points, whose decimals in the scale r ($= 2l-1$, $l \geqq 2$), miss the digit l, or miss the digits $(l-1, l, l+1)$ or miss the digits $(l-2, l-1, l, l+1, l+2)$, and so on, is symmetric and may be an *SD*-set; also the set E of points whose decimals in the scale r ($= 2l$, $l \geqq 2$), miss the digits $(l-1, l)$ or miss the digits $(l-2, l-1, l, l+1)$, and so on, is symmetric and may be an *SD*-set. A family of non-symmetric *SD*-sets has also been considered in this paper.

Functions of Complex Variables

5. A Note on a Theorem of Fabry

S. K. Singh, Dharwar

Theorem : Let $f(z) = \sum_{n=0}^{\infty} a_n z^n$ be a power series whose radius of convergence is unity. If $\lim_{n \to \infty} \frac{a_n}{a_{n+1}} = 1$, then $z = 1$ is a singular point of $f(z)$. The above is a well known theorem of Fabry (see 1, p. 377, Th. II]. The purpose of this note is to give an alternative simple proof of this theorem.

Special Functions

6. On the Bessel Polynomials

S. K. Chatterjea, Calcutta

In connection with certain solutions of the wave equation, Krall and Frink (Trans. Amer. Math. Soc., Vol. 55, 1949, pp. 100–115) considered a system of polynomials $y_n(x)$, known as the Bessel Polynomials. Recently Rajagopal (Amer. Math. Monthly, Vol. 67, 1960, pp. 166–169) has given an interesting representation for $y_n(x)$ in the iterative sense.

In this paper we present two determinant representations for $y_n(x)$, one is derived from the Rodrigues formula and the other from the recursion relation. These determinants have been studied in some details. A continued fraction-expression for $y_n(x)/y_{n-1}(x)$ is derived. Two determinant representations for the Laguerre polynomials $x^n L_n^{(-2n-1)}(2/x)$ are also given. Moreover some recursion relations of $y_n(x)$, which are supposed to be new, are obtained.

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Integral Transforms

7. On Jacobi Transform

L. DEBNATH, Calcutta

The Jacobi Transform $f^{(\alpha,\beta)}(n)$ of $F(x)$ is introduced by means of the integral

$$f^{(\alpha,\beta)}(n) = J\{F(x)\} = \int_{-1}^{+1} (1-x)^{\alpha}(1+x)\beta\ P_n^{(\alpha,\beta)}(x)\ F(x)dx$$

and the following theorems regarding operational properties of the transform have been established.

Theorem 1. If $F(x)$ and $F'(x)$ be bounded at $x = \pm 1$, $F''(x)$ be bounded and integrable in each of the interval $-1 < x < 1$, $J\{F(x)\}$ exists and

$$\lim_{x\to\pm 1} (1-x)^{\alpha+1}(1+x)^{\beta+1}F(x) = \lim_{x\to\pm 1} (1-x)^{\alpha+1}\ (1+x)^{\beta+1}\ F'(x) = 0$$

then $J\{R[F(x)]\}$ exists and $J\{R[F(x)]\} = -n(n+\alpha+\beta+1)\, f^{(\alpha,\beta)}(n)$ $(n=0,1,2,3,..)$.

Theorem 2. If $F(x)$ be integrable in each of the sub-interval of $-1<x<1$ and $f^{(\alpha,\beta)}(o) = 0$ then $f^{(\alpha,\beta)}(n)$ exists and for each constant C

$$J^{-1}\left\{-\frac{f^{(\alpha,\beta)}(n)}{n(n+\alpha+\beta+1)}\right\} = R^{-1}[F(x)] = \int_0^x \frac{1}{(1-s)^{\alpha+1}\ (1+s)^{\beta+1}} \int_{-1}^{s} (1-t)^{\alpha}(1+t)\beta\ F(t)dtds + C$$

(n being a positive integer)

A few recurrence relations for $f^{(\alpha,\beta)}(n)$ and the inverse transformation have been obtained. The Legendre transform of R. V. Churchill (Jour. of Math. & Physics (1954), 33, p. 165–78) and the Gegenbauer transform of S. D. Conte (Quart. Jour of Math. (1955) 6, p. 48) and their operational properties will come out as a particular case of this transform for special choice of α, β.

Finally, the transform has been utilised to solve the heat equation for one dimentional linear flow of heat in the medium $-1<x<1$. Considering a non-homogenous bar with its extremeties at $x = \pm 1$, whose lateral surface is insulated, the solution of the heat-equation

$$\frac{\partial}{\partial x}\left[\ [(1-x^2)\ \frac{\partial}{\partial x}\ U(x,t)\ \right] + \frac{\mu x+\nu}{\lambda}\ \frac{\partial}{\partial x}\ U(x,t) = \frac{\rho, c}{\lambda}\ \frac{\vartheta}{\partial t}\ U(x,t)$$

can be put in the form

$$U(x,t) = \sum_{n=0}^{\infty} (Sn)^{-1}\ g^{(\alpha,\beta)}(n)\ P_n^{(\alpha,\beta)}(x)\ e^{-n(n+\alpha+\beta+1)\ \frac{\lambda}{\rho.c}\ t}$$

8. An Application of Laguerre Transform on the Oscillation of a very long and Heavy Chain

L. DEBNATH, Calcutta

The Laguerre transform $f_{\alpha}(n)$ of $F(x)$ was introduced [Debnath (1960), Bull. Cal. Math. Soc. Vol. 52] by the integral

$$f_{\alpha}(n) = T\{F(x)\} = \int_0^{\infty} e^{-x}\ x^{\alpha}\ L_n^{\alpha}(x)\ F(x)dx$$

In this paper, this transform has been used to solve the partial differential equation

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governing the forced vibration of a very long and heavy chain of mass ρ per unit length, suspended from one end.

Taking the tension of the chain $T = g\rho x$ and the external transverse force actiug on the chain per unit length,

$$P(x,t) = g\rho(\alpha - x + 1)\frac{\partial Y}{\partial x}$$

the solution of the equation

$$x\frac{\partial^2 Y}{\partial x^2} + (\alpha - x + 1)\frac{\partial Y}{\partial x} = \frac{1}{g}\frac{\partial^2 Y}{\partial t^2}$$

where $Y(x,t)$ is the displacement function of the chain from its equilibrium-position, is of the form

$$Y(x,t) = \sum_{n=0}^{\infty} (Sn)^{-1}\,[y_\alpha\,(n,0)\,Ces\,(\sqrt{ng})\,t + y_\alpha{}^1\,(n,0)\,\sin\,(\sqrt{ng})t]\,L_n{}^\alpha\,(x)$$

Summability

9. On the Absolute Riesz Summability Factors of Infinite Series

G. D. Dikshit, Allahabad

1.1. Concerning absolute Riesz summability factors for general infinite series, the author has already published some results (Indian Journal of Mathematics, 1 (1958-59), pp. 33–40; Proc. Nat. Inst. Sci. India, 26A, (1960), pp. 86–94). In these papers, he has discussed the nature of summability factor-sequence $\{\varepsilon_n\}$ which should be such that whenever a series Σa_n is summable $|R, \lambda, \alpha|$, $\alpha \geqslant 0$, the factored series $\Sigma a_n \varepsilon_n$ may be summable $|R, \phi(\lambda), \alpha|$, where function $\phi(t)$ is a positive monotonic increasing function of t and has as many derivatives as one may require. While in the first paper he dealt with the integral order of summation, in the second he had proved a theorem for non-integral order of summation. In the latter one, he had made use of the fractional orders of derivatives of a function. Now he establishes the following theorem in which he does not make use of fractional order of derivatives.

1.2. Theorem. *Let $\phi(\omega)$ and $\psi(w)$ be the $(k+1)$-th indefinite integrals for $\omega \geqslant 0$, where k is the integral part of K (K being non-integral and positive), and let h be a finite positive number. If there exists a positive function $\gamma(w)$ such that*

$$\text{(i)}\quad \frac{\gamma(\omega)}{\omega} = 0(1),$$

$$\text{(ii)}\quad \begin{cases} \omega^n \psi^{(n)}(\omega) = 0\left[\left\{\dfrac{\gamma(\omega)}{\omega}\right\}^{K-n}\right], & n = 1,2,\ldots,k, \\ \omega^{k+1}\psi^{(k+1}(\omega) = 0(1), & \omega \geqslant h, \end{cases}$$

$$\text{(iii)}\quad \{\gamma(\omega)^n \phi_{(}{}^{n)}(\omega) = 0\{\phi(\omega)\},\ n = 1,2,\ldots,k+1;\ w \geqslant h,$$

and (iv) $$\left\{\frac{\gamma(\omega)}{\omega}\right\}^{K-k-1}\left\{1 - \frac{\phi(\omega)}{\phi(t)}\right\}^{K-r}\left\{\frac{\phi(\omega)}{\phi(t)}\right\}^{r} \varepsilon\beta V t(,\omega\infty),$$

uniformly in $w \geqslant h$, $0 < r < k$,

and if with $x = t\sigma + (1-\sigma)u$, $f(t,x,u) = \left\{\dfrac{u}{\phi(t)}\right\}^{x}\left\{\dfrac{(t-x)}{\phi(t)-\phi(x)}\right\}^{k+1-x}$

$$\psi(x)\{\phi'(x)\}^{k+1}\varepsilon\beta V_t\,(u,\infty),$$

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uniformly in $0 < \sigma < 1$ *and* $u > 0$, *then if the series* Σa_n *is summable* $|R, \lambda, K|$, *the series* $\Sigma a_n \psi(\lambda_n)$ *will be summable* $|R, \phi(\lambda), K|$.

10. Absolute Summability Factors of Infinite Series by Rieszian Means

Z. U. Ahmad, Allahabad

In the direction of the 'second theorem of consistency' for absolute Riesz summability, Prasad and Pati (Math. Annalen 140 (1960), pp. 187–197) have recently established two theorems, which are the refinements over a prior result of Guha (Jour. London Math. Soc. 31 (1956), 300–311). Very recently, Dikshit (Thesis (D.Phil), Allahabad University, 1960) has made an attempt to obtain an analogue of theorem 1 of Prasad and Pati (mentioned above) for the absolute Riesz summability factors of infinite series. The object of this paper is to obtain in the form of Theorems 1 and 2, direct analogues of the above mentioned result of Prasad and Pati for absolute Riesz summability factors and a further generalization of Dikshit's result. The theorems are :—

Theorem 1 : *Let* $\phi(t)$ *and* $\psi(t)$ *be defined in* $(0,\infty)$ *and be differentiable as many times as required. If* $\phi(t)$ *be a non-negative monotonic increasing function of* t *for* $t \geqslant 0$, *steadily tending to infinity as* $t \to \infty$, $\phi(t)$ *and* $\psi(t)$ *are the* $(k+1)$*-th indefinite integrals for* $t \geqslant 0$, k *being the integral part of* K (*assumed non-integral*), *there exists a positive function* $\gamma(t)$ *such that*

$$\left.\begin{array}{ll} & \text{(i)} \quad \gamma(t)/(t) \in B(h,\infty), \\ \text{(a)} & \text{(ii)} \quad t^n \psi^{(n)}(t) = O\left[\left\{\frac{\gamma(t)}{t}\right\}^{K+1-n}\right], \; n = 0,1,\ldots,k+1, \; t \geqslant h, \\ & \text{(iii)} \quad \{\gamma(t)\}^n \phi^{(n)}(t) = O\{\phi(t)\}, \; n = 1,2,\ldots,k+1, \; t \geqslant h, \end{array}\right\}$$

for some finite h, *and, uniformly in* $0 < v < 1$ *and* $s > 0$,

$$\text{(b)} \qquad \Omega(s,v,t) \in BV_t(0,\infty),$$

then $|R,\lambda,K|$ *-summability of* Σa_n *implies* $|R,\phi(\lambda),-K|$*-summability of* $\Sigma a_n \psi(\lambda_n)$.

Theorem 2 : *If* $\phi(t)$, $\psi(t)$ *and* $\gamma(t)$ *satisfy the same conditions as in theorem* 1, *with* (b) *replaced by :* (c) $\phi^{(1)}(t)$ *is monotonic non-decreasing,* $t \geqslant 0$, (d) $\psi(t)$ *is monotonic,* $t \geqslant 0$, *then* $|R,\lambda,K|$*-summability of* Σa_n *implies* $|R,\phi(\lambda),K|$*-summability of* $\Sigma a_n \psi(\lambda_n)$.

N.B.: $$\Omega(s,v,t) \equiv sK\left\{\frac{(1-v)t}{\phi(s+t)-\phi(s+vt)}\right\}^{k+1-K} \psi(s+vt)\,\frac{\{\phi^{(1)}(s+vt)\}^{k+1}}{\{\phi(s+t)\}^K}.$$

11. A Theorem on Generalized Absolute Summability

S. M. Mazhar, Allahabad

1.1. Let $C_\lambda^\alpha(w)$ denote the Riesz mean of type λ and order α, of the series Σa_n.

A series Σa_n is said to be summable $|R, \lambda, \alpha|_k$, where $k \geqslant 1$, $\alpha > 0$, $> \alpha k' > 1$ and $1/k + 1/k' = 1$, if the integral

$$\int_h^\infty w^{k-1} \left|\frac{d}{dw} C_\lambda^\alpha(w)\right|^k dw$$

is convergent, h being a finite positive number (Mazhar, Proc. Nat. Inst. Sci., India 26A (1960), 160-167).

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1.2. The object of the present note is to prove the following theorem on the generalized absolute summability given above.

Theorem. *If α is a positive integer and Σa_n is summable $|R, \lambda, \alpha|_k$, then $\Sigma a_n \lambda_n^{-\alpha+1/k'}$ is summable $|R, l, \alpha|_k$, where $l_n = e^{\lambda_n}$, $k \geqslant 1$ and $1/k+1/k' = 1$.*

It may be observed that the above theorem includes, as a special case for $k = 1$, a well known theorem of Tatchell (J.L.M.S., 29 (1954), 49–59) for positive integral values of α.

12. On the Absolute Convergence of Fourier Series

B. S. Yadav, Baroda

Let $f(x)$ be L-integrable in $(0,2\pi)$ and periodic outside with period 2π and let

$$f(x) \sim \sum_{n=1}^{\infty} b_n \sin nx.$$

Set

$$\phi_x(h) = f(x+h) - f(x-h).$$

Izumi [J. Math. Analysis and applications, Vol. I, (1960), 184–194)] has proved the following :

Theorem : If (i) $\int_0^{\pi} \log^{2\pi/x} |\, df(x)| < \infty$ and (ii) the sequence $\{n^{\delta}\Delta(nbn)\}$ is of bounded variation for some $\delta > 0$, then the Fourier series of $f(x)$ converges absolutely, that is $\sum_{n=1}^{\infty} |b_n| < \infty$. This has the cosine series analogue.

In this connection, we shall prove the following :

Theorem : If (i) $\int_I |d\phi_x(h)| \leqslant A|h|^{\alpha}$, $\alpha > 0$, where $I : |x-x_0| < \gamma$, $\gamma > 0$, is any sub-interval of $(0,2\pi)$ and (ii) the sequence $\{n^{\delta}\Delta(nb_n)\}$ is of bounded variation, then $\sum_{n=1}^{\infty} |b_n| < \infty$. We also have the cosine series analogue.

13. On the Absolute Harmonic Summability of the Associated Fourier Series and its Allied Series

Shiva Narain Lal, Allahabad

1. Let $f(t)$ be a periodic function with period 2π and integrable (L) over $(-\pi,\pi)$ and let the Fourier series of $f(t)$ be

$$f(t) \sim \tfrac{1}{2}a_0 + \sum_{n=1}^{\infty} (a_n \operatorname{Cos} nt + b_n \operatorname{Sin} nt) \equiv \Sigma A_n(t) \tag{1.1}$$

Then the allied series of the above series is

$$\sum_{n=1}^{\infty} (b_n \operatorname{Cos} nt - a_n \sin nt) \equiv \Sigma B_n(t) \tag{1.2}$$

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We write

$$\phi(t) = \tfrac{1}{2}\{f(x+t)+f(x-t)\} \tag{1.3}$$

and

$$\psi(t) = \tfrac{1}{2}\{f(x+t)-f(x-t)\} \tag{1.4}$$

We denote by $\{\lambda n\}$ any one of the following sequences,

$$1/\{\log(n+1)\}^{\varepsilon}, \quad \frac{1}{\{\log\log(n+1)\}^{1+\varepsilon}}, \quad \frac{1}{\log\log(n+1)\ \{\log\log\log(n+1)\}^{1+\varepsilon}}$$

$$1/\log\log(n+1)\ \ldots\ \log\log\log_{p-1}(n+1)\ \{\log\log\ \ldots\ \log_p(n+1)\}^{1+\varepsilon} \tag{1.5}$$

2. Recently Pati (On the non-absolute summability of Fourier series by a Nörlund method, under publication in the Jour. of Indian Mathematical Society has proved that "If $\phi(t)\log r/t$ is absolutely continuous in $(0,\pi)$ then the Fourier series is not necessarily absolutely Harmonic summable".

In this paper the author takes $\phi(t)\log(r/t)$ to be only of bounded variation and determines suitable factors $\{\lambda n\}$ that make the Fourier series absolutely Harmonic summable. Further the author also proves the analogue of this theorem for the allied series of Fourier series. More preciesely the following theorems have been proved.

Theorem 1. If $\phi(t)\log r/t$ $(\gamma > e^2\pi)$ is of bounded variation in $(0,\pi)$ then the factored Fourier series $\Sigma A_n(t)\lambda n$ where $\{\lambda n\}$ is defined by (1.5) is absolutely Harmonic summable at the point $t = x$.

Theorem 2. If $\psi(t)\log\frac{r}{t}$ $(\gamma > \pi)$ is of bounded variation in $(0,\pi)$ and $|\psi(t)|/t$ is integrable over the same interval, then the associated allied series of Fourier series $\Sigma B_n(t)\lambda n$ where $\{\lambda n\}$ is defined by (1.5) is absolutely Harmonic summable at the point $t = x$.

14. On the Absolute Riesz Summability of the Conjugate Series of a Fourier Series

S. M. Mazhar, Allahabad

1.1. Let $\lambda = \lambda(w)$ be a continuous, differentiable and monotonic increasing function of w in (k,∞), wihere k is a positive constant and let $\lambda(w) \to \infty$ with w.

We write

$$C_\alpha(w) = \sum_{n<w} \{\lambda(w)-\lambda(n)\}^\alpha a_n, \qquad (\alpha \geqslant 0).$$

A series Σa_n is said to be summable $|R, \lambda, \alpha|$, $\alpha\ \alpha \geqslant 0$, if the integral

$$\int_A^\infty |d[C_\alpha(w)/\{\lambda(w)\}^\alpha]|$$

is convergent, A being a finite positive number.

1.2. Let $f(t)$ be a periodic function with period 2π and integrable(L) over $(-\pi,\pi)$ and let the Fourier series of $f(t)$ be given by

$$f(t) \sim \tfrac{1}{2}a_0 + \sum_1^\infty (a_n \operatorname{Cos} nt + b_n \operatorname{Sin} nt),$$

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then the conjugate series of the Fourier series of $f(t)$ is given by

$$\sum_1^\infty (b_n \operatorname{Cos} nt - a_n \operatorname{Sin} nt) = \sum_1^\infty B_n(t).$$

We write

$$\psi(t) = \tfrac{1}{2}\{f(x+t) - f(x-t)\}$$

$$\psi_\alpha(t) = \frac{1}{\Gamma(\alpha)} \int_0^t (t-u)^{\alpha-1} \psi(u)\, du, \qquad (\alpha > 0)$$

2.1. In this note we establish the following theorem.

Theorem. Let $0 < \alpha < 1$ and $\beta \geqslant 0$. If

(i) $\psi_\alpha(+0) = 0$

and

(ii) $$\int_0^\infty \left(\log \frac{k}{t}\right)^\beta \left| \frac{d\,\psi_\alpha(t)}{t^\alpha} \right| < \infty,$$

then the conjugate series $\Sigma B_n(t)$, at $t = x$, is summable $|R, e^{(\log w)^{1+\beta/\alpha}}, \gamma|$ *for every* $\gamma > \alpha$.

It may be observed that this theorem includes, as a special case for $\beta = 0$, a theorem of Bosanquet and Hyslop (Math. Zeit. 42 (1937), pp. 489–512). It also extends a theorem of Sinha (Proc. Nat. Inst. Sci. India, 24 (1958), pp. 155–175) to the cases $\beta \geqslant 0$ and $0 < \alpha < 1$.

15. On the Absolute Nörlund Summability of the Conjugate Series of a Fourier Series

T. Pati, Allahabad

Let $f(t)$ be integrable (L), periodic with period 2π, and let

$$(1) \qquad f(t) \sim \sum_{n=1}^\infty (a_n \operatorname{Cos} nt + b_n \operatorname{Sin} nt) = \sum_n A_n(t).$$

Then the conjugate series of (1) is

$$(2) \qquad \sum_{n=1}^\infty (b_n \operatorname{Cos} nt - a_n \operatorname{Sin} nt) = \sum_n B_n(t).$$

We write $\phi(t) = \frac{1}{2}\{f(x+t) + f(x-t)\}$; $\psi(t) = \frac{1}{2}\{f(x+t) - f(x-t)\}$. Let Σa_n be an infinite series with partial sums s_n, and let $\{p_n\}$ be a sequence of constants with $P_n = p_0 + p_1 + p_2 + \ldots + p_n \neq 0$. Then if $t_n = \sum_{\nu=0}^n p_{n-\nu}\, s_\nu / P_n \in BV$, that is, if $\sum_n |t_n - t_{n-1}| < \infty$, Σa_n is said to be summable $|N, p_n|$.

The author has recently obtained (Jour. London Math. Soc., 34 (1959), 153–160) a general theorem on the absolute Nörlund summability of a Fourier series at a point, which includes the well-known result of Bosanquet (Jour. London Math. Soc., 1936); if $\phi(t) \in BV(0, \pi)$, then $\Sigma A_n(x)$ is summable $|C, \delta|$ for every $\delta > 0$. In the present paper the author establishes the following theorem, which contains as a particular case the corresponding result on $|C|$ -summability of the conjugate series, due to Bosanquet and Hyslop (Math. Zeitschr., 1937).

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Theorem. If $\psi(+0) = 0$, $\psi(t) \in BV(0, \pi)$, $\int_0^{\pi} (|\psi(t)| / t)\, dt < \infty$, and if $\{p_n\}$ is a positive monotonic sequence of constants such that $P_n \to \infty$ with n, $(n+1)p_n/P_n \in BV$ and $\sum_{\nu=0}^{n} (\nu+1)^{-1} P_\nu / P_n \in BV$, then $\Sigma B_n(x)$ is summable $|N, p_n|$.

Differential Geometry

16. Curves and Invariants associated with a Vector Field of a Riemannian V_m in Relation to a Curve in a Subspace V_n.

C. N. Srinivasiengar and K. Nirmala, Dharwar

In two papers (*Tensor*, Vol. VI, 1956), and *Ganita* (Vol. 3, 1952), Dr. R. S. Mishra and Shri Krishna consider congruences in V_m, which are such that through each point of a subspace passes one curve of each congruence. Calling λ_τ/as the tangent vector to the curve of one of the congruences, they define absolute curvature, and normal curvature of a curve C in V_n with respect to λ_τ/. In this paper, we similarly introduce geodesic curvature of C *w.r.t.* λ_τ/, and we obtain several neat results regarding these curvatures. We may mention here the elegant result :

The tendency of λ_τ/ *w.r.t.* C in V_m = its tendency *w.r.t.* C in $V_n - k_n \cos w_\tau$/ where k_n is the normal curvature vector of C, and w_τ/ the angle between this vector and λ_τ/.

17. On a type of Riemannian Space

M. C. Chaki, Calcutta

This paper deals with a type of Riemannian space $V_n (n > 3)$ for which the covariant derivative of Weyl's conformal curvature tensor is everywhere zero. In the first few sections, spaces of this kind have been considered in relation to other well-known classes of Riemannian spaces defined by curvature restrictions. In the remaining part, the question of conformal mapping of Riemmanian spaces on such a space has been discussed.

18. Generalized Gauss, Codazzi and Kuchne Tensors

K. D. Singh, Lucknow

Generalised Mainardi-Codazzi relations have been obtained by Mishra (1952) by taking tangents for a set of $(m-n)$ congruences of curves which are such that through each point of V_n embedded in V_m a curve of each congruence passes.

Gauss, Codazzi and Kuehne tensors and their derived tensors have been defined and studied by Blum (1946, 1947, 1955).

In this paper these tensors given by Blum have been generalised for a generalised Riemann space. It has been proved that these tensors do not explicitly depend upon the enveloping space and hence they have the same form as the corresponding tensors of the space with respect to an enveloping Euclidean space.

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19. Parallelism and Covariant Differentiation in a Generalized Finsler Space

A. C. Shamihoke, Kanpur

A generalised Finsler space has been defined in this paper which essentially differs from a Finsler space in the non-symmetric character of the metric tensor. The approaches of both H. Rund as well as E. Cartan have been generalised, i.e., there are two types of generalised Finsler spaces : one constituting the generalisation of the Finsler spaces of H. Rund and the other constituting the generalisation of the Finsler spaces of E. Cartan. The problem of parallelism and covariant differentiation has been solved for both types of generalised Finsler spaces. The connection parameters found out for them reduce to the connection parameters Δ^i_{hk} of Eisenhart if the metric tensor $g_{ij}(x,\dot{x})$ is independent of the directional argument. The length of a vector undergoing parallel transport in the direction of its element of support remains unchanged for a generalised Finsler space based on an approach similar to E. Cartan.

20. Gauss-Codazzi Equations in a Hyperspace imbedded in a Generalized Finsler Space

A. C. Shamihoke, Kanpur

This paper deals with hypersurfaces of a generalized Finsler space with special reference to Gauss-Codazzi equations. The two sets of normals, projection factors, Coefficients of second and secondary second fundamental forms have been defined. Gauss-Codazzi relations have been obtained both with the help of the coefficients of second fundamental form as well as the coefficients of secondary fundamental form. Corresponding results for Finsler spaces and generalized Riemanniem spaces follow as particular cases.

Statistical Mechanics

21. Statistical Mechanics of Continuous Media : Vibrations of Membranes

N. E. Joshi and S. D. Nigam, Kharagpur

Methods of classical statistical mechanics have been extended to the mechanical system of infinite number of degrees of freedom and the vibrations of a circular homogeneous membrane with infinite radius have been studied. Vibrations only with circular symmetry have been considered. Suitable *function space*, instead of classical *phase space*, has been defined. To introduce a suitable probability measure the following two specific cases have been studied in detail.

1. The wave numbers are distributed according to the Poisson's distribution.
2. The function space consists of Wiener-Levy Brownian motion functions.

The random integrals thus arising, due to the randomness of the initial conditions, have been discussed.

In the case (1), the displacement and velocity turn out to be almost periodic functions in time and stationary in time. In (2) the displacement and velocity functions have been found to be random, normal functions, stationary in time. Necessary ergodic theorem has been proved.

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Ballistics

22. The Second Ballistic Problem on the Theory of Motion of a Spinning Shell

P. C. Rath

In this note we have studied qualitatively the nature of small oscillations of the shell-axis about its normal position on the mean twisted trajectory. A solution of the second ballistic problem is obtained for the restricted case of low angle fire. As the motion along the mean trajectory is obviously of a stable shell, the characteristic lines of oscillations show a stable node at the normal position.

Elasticity

23. Note on Torsional Oscillations of a Semi Infinite Circular Cylinder with some simple types of Applied Twists at one End

A. K. Mitra, Calcutta

In the present note two very simple problems of torsional oscillations of a semi-infinite circular cylinder have been considered. The first problem is concerned with the setting up of disturbance in the cylinder by an impulsive twist applied at one of its ends, the curved surface of the cylinder being free from stress. In the second case it is assumed that the end experiences only a single pulse.

24. Bars Reinforced by Hyperboloidal Type Notches under Pure Bending

S. C. Das and R. Subramanium, Madras

Investigations have been made to obtain the stresses in a round bar with a circumferencial notch, generated by the rotation of a hyperbola about its axis coinciding with that of the bar, reinforced by another elastic material when the bar is under pure bending. Results have been obtained in closed forms. The cases of similar bars under torsion (Proc. Fifth. Cong. on Theo. & Appl. Mech., 1959) and under tension (Proc. Ind. Sc. Cong., 1961) have been previously dealt with by Das.

25. Stress Distribution in a Rectangular Plate of Piezoelectric Crystal under Normal Pressures

H. S. Paul, Kharagpur

Solutions of two-dimensional static problems of certain piezoelectric crystals have been solved by Fourier's method for rectangular plates. Two opposite edges of the plate are assumed to be free while normal pressures are applied on the other two edges. These edges are kept at zero electric potentials. The stresses, the strains and the electric displacements have been calculated. Numerical results for α-quartz have been given to illustrate the shearing stress distribution at free ends.

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26. Two Dimensional Elliptic Inclusion

R. D. Bhargava and H. C. Radhakrishna, Kanpur

The simple concept of minimum potential energy of the classical theory of Elasticity first applied to solve Inclusion problems by one of the authors (RDB) to spherical and circular inclusions, has now been extended to solve elliptic inclusion problems. The complex variable method of determining the elastic field, first enunciated by Stevenson, A.C. in U.K. and Mushkelishvli, N.I. in U.S.S.R., has been used to determine the elastic field in the infinite material (called matrix) around the inclusion. Strain energies are calculated. The equilibrium size of an elliptic inclusion of elastic constants λ' and μ' differing from those of the matrix for which the constants are λ and μ has been determined.

The independent check on the calculations has been made by testing the continuity of normal and shearing stresses. The results also agree with the known results for much simpler case, when inclusion and matrix are of the same material.

27. On Magneto-Thermoelastic Plane Waves

Gunadhar Paria, Kharagpur

The propagation of plane waves in a thermoelastic body placed in a magneric field has been investigated. It is shown that the problem can be reduced to one of pure thermoelasticity, provided, the longitudinal elastic wave velocity is suitably increased in the case of infinite electrical conductivity. For the finite electrical conductivity, however, the thermoelastic coupling factor is to be increased if the frequency is low.

28. Magnetoelastic Wave Propagation

P. D. Nigam, Kharagpur

The effect of uniform, externally applied magnetic field on the directional distribution and attenuation of waves created by a localized periodic body force in a homogeneous, isotropic elastic solid extending to infinity has been studied using a technique developed by Lighthill. In the absence of the magnetic field irrotational waves and the equivoluminal waves propagate in all directions with velocity V_p and V_s respectively and they decay like r^{-1} in all directions. In the presence of the magnetic field, the waves still propagate in all directions but the velocity of irrotational waves increases from V_p along the magnetic lines of force to $\sqrt{V_p^2+a_1^2}$ at right angles to them and they decay like r^{-1} in all directions. The velocity of equivoluminal waves increases from V_s at right angles to the magnetic lines of force to $\sqrt{V_s^2+a_1^2}$ along them and in certain directions they decay like $r^{-5/6}$ and in all other directions they decay like r^{-1}.

Fluid Mechanics

29. Görtler's new series Method for Compressible Laminar Boundary Layer Flows with Pressure Gradient and with or without suction

A. C. Jain, Bangalore

The aim of the present note is to extend the recent important method given by Görtler (J. Math. Mech., Vol. 6, No. 3, pp. 323-340, 1959) for incompressible flows

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with suction to compressible flows with suction. This aim is achieved by transforming the boundary layer equations for compressible flows to the forms obtained for incompressible flows through a number of transformations. The present analysis is carried out for the class of outer velocity distributions

$$U(x) = x^m \sum_{k=0}^{\infty} u_k x^{k(m+1)}, \; m \neq -1$$

(x being the distance along the body from its forward point) and the suction velocity distribution

$$v_0(x) = x^r \sum_{k=0}^{\infty} v_k x^{k(m+1)}$$

when the Prandtl-number is unity, viscosity-temperature relation is linear and there is no heat-transfer. Salient features of the present method are the following :

(i) The effect of compressibility appears only in the transformation of the tangential and normal coordinates and in the coefficients of the principal function.

(ii) The present analysis does not require more universal functions than are necessary for the incompressible flow with suction. The case of an impervious wall appears as a particular case.

(iii) Similar solutions are obtained as a particular case when $M_1 \propto (\xi_2)^{\beta_0/2}$ and $v_0(x) \propto \xi_2^{\frac{1}{2}(\beta_0-1)}$ when M_1, a_1 are respectively the Mach number and the velocity of sound in the outer flow and ξ_2 is related to x.

(iv) Calculations are extended upto the fifth order approximation so as to make full use of the available integrated universal functions.

(v) In the case of an impervious wall, the effects of compressibility and pressure gradient on the skin-friction is studied by means of a number of graphs.

30. Slow Motion of a Non-Newtonian Liquid past a sphere

(Miss) S. L. Rathna, Bangalore

The theory of non-Newtonian fluids is based on the stress-rate of deformation relation given by

$$T = -pU + \phi_1 E + \phi_3 (E.E),$$

where T, E, p, ϕ_1 and ϕ_3 are the stress tensor, rate of deformation tensor, pressure and coefficients of viscosity and cross-viscosity respectively. In the present paper, the flow of a non-Newtonian liquid past a sphere of radius a, which, at infinity is uniform, has been studied. For small Reynolds number the inertia terms can be neglected in comparison with viscous terms. The stream function is obtained in terms of a non-dimensional parameter $R = \dfrac{\phi_3 U}{\phi_1 a}$, where U is the velocity of the uniform stream. Assuming R to be small, only terms upto the second power in R have been retained. The zeroth order approximation corresponds to the Stokes' solution for the Newtonian fluid.

The drag on the sphere and the pressure distribution have been obtained. Unlike the case of visco-elastic fluids, the drag on the sphere to present approximation is greater than the drag due to a Newtonian fluid by the quantity $255.7512\, \pi a U \phi_1 R^2$. The effect of cross-viscosity on the stream lines have been represented graphically.

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31. Laminar Boundary Layer on Rotating Sphere and Spheroids in Non-Newtonian Fluids

(Miss) G. K. Rajeswari, Bangalore

In this paper the three dimensional laminar boundary layer equations are deduced in orthogonal curvilinear coordinates, in non-Newtonian fluids, whose constitutive equation is given by

$$T = -pI + \phi_1 E + \phi_3 (E.E)$$

where T is the stress tensor, p an hydrostatic pressure, E is the rate of deformation tensor, I the idem tensor and ϕ_1 and ϕ_3 are the constant coefficients of viscosity and cross-viscosity respectively. Making use of these boundary layer equations, the flows in the boundary layer generated by a rotating sphere, rotating prolate and oblate spheroids are investigated separately. When these bodies of revolution are rotated about the axis of revolution, in an otherwise undisturbed fluid, the accompanying secondary stream causes the fluid to flow into the boundary layer near the poles and out of it at the equator. Near the poles the flow is the same as that due to rotating disc. However, the phenomenon in the plane of the equator where the two boundary layers impinge on each other and are thrown outwards can no longer be analysed with the aid of the boundary layer theory. The effect of cross-viscosity on the flow is discussed within the boundary layer originating from the poles on these rotating bodies before they impinge on each other near the equator. All the velocity components are expressed in terms of the series in powers of $\sin\theta$, θ being the angle measured from the axis of rotation in a meridian plane and the coefficients are purely functions of the normal distance from the surface of the revolution. These unknown functions are determined using the Karman-Pohlhausen method. The effects of cross-viscosity are represented through a non-dimensional parameter $K = \frac{\gamma\Omega}{\alpha}$, where α, γ, Ω are respectively the kinematic coefficients of viscosity, cross-viscosity and the uniform angular velocity of the rotation of the body. The effects of both positive and negative K on the flow functions are illustrated graphically.

32. Shear Flow of an Elastico-viscous Fluid past a Flat Plate with Suction

Shankar Prasad Misra,* Kharagpur

The shear flow of an Elastico-viscous fluid past a flat plate with suction has been studied by considering the constitutive equations

$$\tau^{i}_{j} + \lambda_1 \tilde{\tau}^{i}_{j} = 2\mu d^{i}_{j}$$

$$\rho \left\{ \frac{\partial v^i}{\partial t} + v^{i}_{,j} v^j \right\} = -\frac{\partial p}{\partial x_i} + \tau^{i}_{j,j}$$

---

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where

$$\overset{\sim}{\tau}{}^{i}_{j} \equiv \frac{\partial \tau_j{}^{i}}{\partial t} + \tau,^{ij}{}_{k}\, v^{k} - \tau^{ik}\, v^{j},_{k} - \tau^{kj}\, v^{i},_{k}$$

is the rate of stress tensor,

$$2d^{i}_{j} = v,_{i}{}^{j} + v,_{i}{}^{j}$$

is the rate of flow tensor, v^i is the velocity vector and p is the mean pressure, λ_1 is an elastic parameter, μ is a coefficient of viscosity.

The discussion shows that the presence of elastic element in a shear flow decreases the boundary layer thickness. A non-zero normal stress $\tau_x{}^x$ is found which is necessary to stabilize the flow. The order of the boundary layer thickness remains unaffected whether the plate moves or is at rest. A previous result of Sakurai restricted the appearence of boundary layer nature to the case of suction only. But here the boundary layer appears in case of injection also.

33. Three Dimensional Flow round a Mountain

P. K. Das, New Delhi

The present paper attempts a solution of the problem of three dimensional flow round a mountain. The basic motion is assumed to be steady with a mean zonal current which does not change with height. The presence of the mountain is taken to produce perturbations on the basic current. After linearising the perturbation equations, a partial differential equation is developed for the vertical component of perturbation momentum. The solution of this equation is obtained in terms of a Green's function for an infinite region.

Mathematical Physics

34. Causality and the Dispersion Formulae for Waves in a Plasma

T. Pradhan, Cuttack

The principle of causality which states that the effect cannot precede the cause, is invoked to obtain the correct prescription for integrating across the pole in the dispersion formulae for the longitudinal and transverse waves in a collision-free plasma obtained by the simultaneous solution of Maxwell's electromagnetic and linearised Boltzmann's transport equations. Conditions for growing and decaying waves are obtained from the results that follow from the above prescription. An analysis of the nature of the initial disturbance is also given.

35. Field Operators and their Analytic Properties

S. P. Misra, Cuttack

The analytic structure of the Fourier transforms of the field operators for positive times is examined. Asymptotic conditions of coordinate space is related to the analyti-

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city property in momentum space, but it has not been possible to utilise it in the perturbation analysis. For menson-nucleon system, which is taken as an illustration, it is seen that the degree of divergence for mass renormalisation is sensitive to the way in which the singularity in complex k_0-plane is taken, and about this we do not have any convincing mathematical or physical reasons except *ad hoc* assumptions based on the possibility of an iterative solution.

36. Oscillations of a three-component assembly in the presence of magnetic field using the Generalization of BGK-collision model

P. L. Bhatnagar and C. Devanathan, Bangalore

The model collision process for a single component assembly of particles proposed by Bhatnagar, Gross and Krook has been generalized for a multicomponent assembly of both charged and neutral particles. The method of obtaining the collisional temperatures and velocities from phenomenological laws is given. Applying this, exact continuum equations of an assembly composed of ions, electrons and neutral particles have been derived and small amplitude oscillations are studied. Confining the attention to the propagation perpendicular to the magnetic field the transverse and longitudinal part separate out. Due to the presence of neutral particles, Landau damping occurs, as the particles moving with the velocity of wave deprive the assembly of their kinetic energy, due to resonance. In the presence of the magnetic field, there would be no oscillation with frequency near the integral multiples of gyrofrequency of electrons and ions. Apart from these microscopic effects it has been found that there could be no transverse oscillation below the critical frequency $\sqrt{4\pi e^2 N_0(\frac{1}{m_1}+\frac{1}{m_2})}$, and in the presence of a strong magnetic field, there are bands of frequency range inside this at which transmission could take place. These depict the high medium like behaviour of the assembly. Thus the proposed method is capable of treating both the microscopic and macroscopic properties simultaneously. Further, because of the simplicity of the model, collisional effects can be evaluated directly.

Relativity

37. Homogeneous Non-Static Electromagnetic Fields in General Relativity

Bidyut Kumar Datta, Calcutta

The paper presents the spatially homogeneous solutions of the Rainich equations of the 'already unified theory' for the case when the field is non-static and the diagonalised metric tensor components are functions of time alone. Except for some specified values of time, the solutions are everywhere regular.

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SECTION OF STATISTICS

PRESIDENT : DR. C. CHANDRASEKARAN

Abstracts

Statistical Inference

1. **Minimum Logit χ^2 estimates of parameters using the logistic functions**

A. P. BASU, Kharagpur

In Test theory, it has been pointed out by several authors that in situations in which "an integrated normal response law" is assumed, the logistic function provides a useful alternative to the probit model. In this paper parameters have been estimated by the minimum logit χ^2 method using the logistic model and the advantage of these estimates over the corresponding maximum likelihood estimates have been discussed.

2. **On a test for the Scale Parameter of the Truncated Exponential Distribution**

ASITPRAKAS BASU, Kharagpur

In sampling from an exponential distribution the assumption that the random variable X is defined over $(0,\infty)$ is not always a realistic one and a sample of n from an exponential distribution is in reality a sample of n from a truncated exponential distribution. In this paper we have examined the effect of applying same usual test of hypothesis to the case when the sample is known to have come from a truncated exponential population and have shown that there will always be some negative "loss of power" of the test.

3. **Simplified method of fitting the doubly or singly truncated Negative-Binomial distribution**

C. G. KHATRI, Baroda

By defining the doubly truncated Negative-Binomial distribution as

$$P_j = \binom{k+j-1}{j} \theta^j \Big/ \sum_{j=a}^{b} \binom{k+j-1}{j} \theta^j$$

where $j = a, a+1, \ldots, b$, $\infty \geqslant b > a \geqslant 0$, and $0 < \theta < 1$, we propose the estimates $\bar{\theta}$ and $\bar{k}$ as

$$\bar{\theta} = A/B \quad \text{and} \quad \bar{k} = C/A$$

where $A = [\Sigma i(i+1)f_{i+1}]\ (\Sigma f_i) - [\Sigma(i+1)f_{i+1}]\ (\Sigma i f_i) + \Sigma i f_i - a f_a$, $C = [\Sigma(i+1)f_{i+1}]\ \Sigma i^2 f_i) - [\Sigma i(i+1)f_{i+1}]\ (\Sigma i f_i) - \Sigma i^2 f_i + a^2 f_a$ and $B = (\Sigma i^2 f_i)\ (\Sigma f_i) - (\Sigma i f_i)^2$, by

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taking f_i the observed frequency at $j = i$ and Σ the summation over i from a to $b-1$. The formula for the asymptotic efficiency of these estimates are established and the above estimates are found to be reasonably efficient (a) for exploratoiry work and (b) for solving the maximum likelihood equations. In a numerical example, the fitting is done by the method of maximum likelihood and by the simplified method.

4. On Multi-sample Non-parametric Location Tests Based on the Differences of Exceedances on Complementary Sample Quantiles

PRANAB KUMAR SEN, Calcutta

Non-parametric median tests for multi-sample location problems are due to Mathisen (1943), Mood (1949), Brown and Mood (1951), among others. Here is studied the following test.

Let $x_{1(r)}$ and $x_{1(n_1-r+1)}$ be respectively the p-th and the $(1-p)$-th sample quantiles of the first sample $(0<p\leqslant\frac{1}{2})$ and let in the i-th sample of size n_i, K_{i1}(and K_{i2}) observations have values less than $x_{1(r)}$ (and greater than $x_{1(n_1-r+1)}$) for $i = 1,\ldots,c$. The proposed test is then based on $K_i = K_{i1} - K_{i2}$ for $i = 1,\ldots,c$. It may be noted that in the particular case $p = \frac{1}{2}$ our test reduces to the median test.

The consistency, asymptotic power and power-efficiency of the test are studied here and it has been shown here that we can always find a value of p, such that our test will be at least as efficient as the median test.

In cases where the efficiency of the median test is quite low, we can have more efficient tests from the class of tests referred to above.

5. On the Role of Non-parametric Inter-quantile Tests in Some Multi-sample Scale Problems

PRANAB KUMAR SEN, Calcutta

Let $x_{i1},\ldots,x_{in_i}$ be n_i units drawn at random from a population with a (unknown) continuous cumulative distribution function $F_{i(x)} = F([x-\mu_i]/\delta_i)$ where μ_i and δ_i are respectively the location and the scale parameters of the i-th population for $i = 1,\ldots,c$ $(c\geqslant 2)$. The first problem relates to testing the homogeneity of the scales, assuming the identity of the locations and the second problem relates to testing the homogeneity of the scales without presuming the identity of locations.

The inter-quantile tests proposed here are consistent for the first problem and their power properties are studied here and compared with that of the Quantile tests. For the second problem, obviously the ordinary inter-quantile tests are not consistent and accordingly, the observations are centered at their respective locations, as estimated from the samples. The inter-quantile tests based on these centered values are consistent and asymptotically distribution-free, under certain regularity conditions and have the same power properties as that of the ordinary inter-quantile tests. But quantile tests based on these centered values, fail to be distribution-free, even under somewhat more restrictive regularity conditions. Hence, the supremacy of our test.

6. Maximum Likelihood Estimation of a Truncated Chi-distributed Radial Error from Grouped Observations

B. K. SHAH and C. G. KHATRI, Baroda

The frequency function of the radial error is

$$f(x) = C(x^{p-1} / \sigma^p) \exp(-x^2 / 2\sigma^2),\ 0<x<\infty,\ \sigma>0$$

where C is not depending on σ, and p is known. The observations in the range

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$x_1 \leqslant x \leqslant x_{k+1}$ are grouped into k specified intervals with end points $x_2, \ldots, x_{k+1}$ and let the frequency in the i-th group be n_i $(i = 1,2,\ldots,k)$. The maximum likelihood equation for σ is established for any p and in particular when $p = 2$, it is given as

$$\Sigma n_i \left[-\frac{\phi_{i+1}\left(x_{i+1}^2 - x_i^2 \right)}{\phi_i - \phi_{i+1}} + \frac{\phi_{k+1}\left(x_{k+1}^2 - x_1^2 \right)}{\phi_1 - \phi_{k+1}} \right]$$

$$+ \Sigma n_i \left(x_i^2 - x_1^2 \right) = 0$$

where

$$\phi_i = (2\pi)^{-\frac{1}{2}} \exp^{(-t^2/2)} \quad \text{and} \quad t_i = x_i/\sigma.$$

Also, it is shown that the first term in the above equation is monotonically decreasing as σ increasing from 0 to ∞. This property helps in solving the above equation.

Applied Statistics

7. On the 'Zero Error' in data collection

M. A. El-Badry, Bombay

It has been observed that enumerators sometimes fail to record a zero answer properly on the schedules. Contrary to the instructions, they leave the relevant space blank or fill it with a mark different from the one given in the instructions (like a '—' for example). When the schedules are returned for processing, such cases are ambiguous and the coders have no way of knowing whether a zero answer or a 'not given' answer is intended. A frequent procedure is to tabulate these ambiguous cases in the 'not given' category.

This paper shows the existence of this error in the census data on 'number of children ever born' which have been collected in many countries, particularly those of South East Asia, including the experience of two Indian states in the 1951 census. A study of the covariation of the proportions tabulated as childless and as 'not given' in the various age groups has shown the existence of a linear or nearly linear relationship between the two proportions in many instances. The linearity can be utilized, as explained in the paper, to detect the existence of the error and to adjust the data.

8. Construction of Rotatable Design through balanced incomplete Block Design with unequal sizes

M. N. Das and V. L. Narasimha, New Delhi

A method of construction of second order rotatable design through balanced incomplete block design with unequal block sizes, has been described. Through this method such designs with any number of factors can be obtained. In the case of many designs the number of points required for a design is very much lower than that obtainable through ordinary B.I.B. designs and other methods.

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9. Some important Psychophysical Laws examined

Amal Kumar Mallick, Calcutta

In order to put them to an empirical test, three important Laws of Psychophysics, viz., Weber's Law, Fulberton-Cattell's squareroot law, and Guilford's n-th power function law, have been applied to some sets of data on temporal estimation obtained in a psychophysical experiment. How far each of the laws is applicable to the data has been examined by studying the relation between the experimental observations and the theoretical expectations. Which of the laws conforms best to the data, i.e., to which law the data give satisfactory fit, has been examined.

10. A Note on Spatial (regional) Productivity Changes

Girija Prasad Mukerji, Calcutta

Temporal studies on 'Productivity Changes' (Nicholson and Gupta JRSS 1960) show high positive correlation between 'Productivity Changes' and 'output'. Similar relationships have been observed by Lomax (JRSS, 1959), Maddison (Bull. Oxf. Inst. Stat. 1955) and Solomon Fabricant (NBER Occ. Paper 63, 1959) between Productivity changes, output and allied factors. The 'Spatial' counter study attempted here does not reveal any such marked association for Indian industries.

Here only six major industries are studied viz. jute, cotton, sugar, cement, paper and iron and steel. Data from the final report of the eleventh census of Indian manufactures have been used. Rank correlation co-efficient between Productivity (defined as output per man-hour) changes and output, employment, earnings, plant and machinery, cost of production, value added by manufacture and degree of mechanization are studied. The fluctuation of the rank correlation coefficient is rather wide and as such no definite conclusions can be reached except that there seems to be no marked association between 'Productivity Changes' and 'output' (as recorded for temporal counterpart). Cost of production also appears to be somewhat negatively associated with productivity.

11. On the Economic Aspects of Sampling Inspection

S. S. Rajput and N. K. Chakravarti, Kanpur

Sampling inspection is not necessarily more economical than 100% inspection, and hence arises the need to investigate conditions which must be satisfied in order for sampling inspection to be more economical. These conditions have been developed in acceptance-rejection, and acceptance-rectification plans. The conditions turn out to be simple inequalities involving fraction defective in the accepted lots (or processes average), sampling fraction, and probability of acceptance of a lot having fraction defective equal to process average. The sampling scheme is to be tested for economy in three steps, so that it is convenient to apply in practice. It saves a lot of computational labour as well, in the sense that if some initial conditions are not satisfied, we reject the plan immediately, thereby saving heavy computations for later conditions.

The risk of resubmission of already rejected lots is discussed here. The conditions that tempt a supplier to resubmit already rejected lots, and the effective countermeasures that the customer may adopt, have been discussed.

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Purchasers of stray and infrequent lots are not interested in protection on the average, but in protection in respect of the submitted lot itself. They are thus primarily interested in the LTPD. It is shown that even in such cases, AQL has to be an important consideration.

The above represent considerations of economy achievable immediately on introduction of sampling inspection. From the long term point of view, sampling inspection is preferable to screening in order to provide the proper incentive to the suppliers for improving the quality of their produce.

12. A study of relative performances of college students of different Ages

J. Sarangi, Cuttack

In pursuance of the query of the University Grants Commission into the desirability of imposing a minimum age limit for admission into first year of the 3-year degree course, the author compared the academic performances of students of different ages in the I.A. examination. Taking the total of standardised scores as the index of merit, the *F*-test of significance established age as an assignable cause of variation of academic performances at 1% level of significance. Arranging the mean scores in decreasing order of magnitude, the different age-groups could be ranked as follows :

16, 17, 15, 18, 14, 19, 22, 21 and 20

Critical differences between successive age-groups revealed no tangible differences. But the average performance of the 16 and 17 or 16, 17 and 15 taken together is superior to the average performances of the other age groups even at 1% level. The average performance of the 20, 21 and 22 groups taken together is inferior to each one of the remaining age-groups at 1% level. Thus whereas students of 16 and 17 age-groups have best performances in colleges, those that cross the twentieth year are far inferior to the rest.

13. Selection within lines in a mixed population

S. N. Sen, Patna

In any system of inbreeding, the population divides into a number of lines. Any amount of selection within lines ultimately leads to the complete homozygosity of the population (Haldane, 1956). In the mixed population where both selfing and natural crossing are present in varying proportions, the rate of disappearance of the heterozygosity at successive generations will be at a slower rate than in case of purely self-fertilized populations. Different cases of selection procedures arising in such mixed populations have been studied earlier in detail (Sen, 1958 and 1960).

In the early stages of the breeding programme, the heterozygous lines split and out of them, some homozygous lines are discarded in each generation. Selection within lines in the mixed population, where some homozygous lines obtained by selfing the heterozygous lines are at disadvantage, are discussed in the present paper. Cases where the measures of selections for the two homozygous lines are either equal or unequal have been studied. If homozygosis is being sought, then the inbreeding should be as close as possible.

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14. A Method of Estimating variable Engel Elasticity

PARAS NATH SINGH, Calcutta

It is well known that the elasticity of demand for any commodity varies with income or total expenditure. This problem has been attacked by extending the famous double log form, wherein the elasticity of demand is supposed constant. The formulation suggested has some of the interesting properties of demand functions.

It has been shown that the basic parameter occurring in the suggested formulation can be estimated with the help of the concentration curves, provided the distribution of total per capita consumption can be described by three parameter log normal distribution. The parameter can also be estimated using least square techniques.

Some empirical studies have also been made, and the elasticities have been given at mean total expenditure of the expenditure classes. However, the significance of these estimates is more or less illustrative, because the third parameter occurring in the log normal distribution has been arbitarily fixed.

15. Simulation of Third Order Systems with one Operational Amplifier

L. K. WADHWA, Delhi

The third order linear system simulation by electronic analog computers is generally done with two or more operational amplifiers by techniques that are very well known.

A method has been discussed in this paper which shows that third order linear systems can be simulated with the aid of only one operational amplifier and a few two-terminal impedances consisting of resistors and capacitors only.

Three possible circuits capable of simulating a particular case of the general third order linear system have been presented and the resulting third and fourth order non-linear algebraic equations have been solved for determining the validity conditions and the circuit component values.

The method of simulation is simple. If the validity conditions are satisfied then a physically realizable net-work consisting of one operational amplifier, three capacitors, five resistors exist and the component value may be easily calculated from the equation developed in the text.

16. One Operational Amplifier Simulator for a Third Order System with a Leading Time-Constant

L. K. WADHWA and JAGDISH CHANDRA, Delhi

In another paper presented to this session, one particular case of a general third order system was considered. In this paper another case of the general third order linear system with one leading time-constant is considered.

Only three of the possible sixteen circuits are discussed in the text. The circuits given in the text have been analysed and the resulting third degree non-linear algebraic equations have been solved with a view to determining the validity conditions and the component values.

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The method of simulation is simple. If the validity conditions are satisfied then a physically realisable network consisting of one operational amplifier, four capacitors and four resistors exists and its component values may be easily calculated from the equations developed in the text.

Demography

17. Sources affecting knowledge and use of certain Family Planning Methods : Some Indices for Assessment

PRAFULLA C. BEBARTA, Bombay

An attempt is made in this paper to devise certain indices to assess the role of different information sources in the propagation of certain family planning methods. Three indices were constructed to measure the role with reference to (1) Knowledge, (2) Use and (3) Knowledge and use, of the methods. The assessment was made with respect to specific sources and also with reference to specific methods and sources.

The knowledge index was constructed by taking the ratio of persons who obtained knowledge about methods from a specific source to the total number of persons with knowledge of methods. A similar index, using in the numerator the number of users who obtained knowledge about methods from a specific source, formed the use index. The knowledge-use index was obtained by working out the ratio of the use and knowledge indices.

The indices were applied to data obtained from 666 women specially interviewed in Bombay City. The findings reveal that different sources perform different functions in the propagation of methods. The study has methodological as well as practical implications.

18. An Evaluation of the Parity Data collected at Birth Registration in Bombay

M. A. EL-BADRY, Bombay

Unlike many other eastern localities, Bombay has a high proportion of its births, as high as about 85%, taking place in hospitals. As these births get automatically registered, the percentage of registration is considered to be quite high. This fairly high degree of completeness has encouraged us at the Demographic Training and Research Centre, Bombay, to utilise the information on parity available on the birth certificate, namely the order of pregnancy and the order of live birth, to assess fertility differences between various socio-economic strata in the city.

The present paper is confined to a pilot study undertaken by the Centre to evaluate the accuracy with which these data on parity are reported. For that purpose, it was decided to take a sample of 1000 mothers of babies born within one year, interview and question them about the details of their marital and pregnancy histories and then match the interview figures on pregnancies and live births with their registration counterparts.

The study revealed the existence of errors in the registration data, due to the wording of the questions as well as to the procedures by which the information was collected. A number of suggestions for enhancing the accuracy of the data are made in the paper.

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19. Techniques for projecting urban-rural Populations and Labour Force

T. B. Im, R. E. Choudhuri and K. V. Ramachandran, Bombay

Many of the economically under-developed countries of the ECAFE region have in recent years exhibited several similarities with regard to demographic and other characteristics. Quite a few of them have recently emerged as independent nations faced with tremendous problems of economic and social reconstruction and development. The population growth in most of these countries are very large mostly due to reduced mortality rates, with no corresponding reduction in fertility rates. The need for planned economic and social development on the basis of the demographic variable requires no special stress.

The demographic statistics of most of these countries leave much to be desired. Many of them even lack the essential pre-requisites of even a recent census, letting alone the availability of registration or survey data. Manpower resources and labour force estimations thus become particularly difficult.

The labour force is affected by several social, economic and psychological factors. Urban-rural characteristics, age and sex play important roles. Some of the other factors may be marital status, family responsibilities, education and so on. Many of the countries may have data at the most on labour force participation by age, sex and urban-rural characteristics.

This paper essentially deals with the techniques of projecting the urban and rural populations by age and sex and using these in conjunction with the projected labour force participation rates also by age and sex. A new technique of projecting the labour force participation rates is also indicated.

The method is applied to estimate the labour force in the Republic of Korea.

20. A study on twinning

K. R. Rajagopalan, Madras

The paper is a study about Births and Twin Births for the decade 1949–58 in Madras City. The data were obtained from all the five of the Maternity Hospitals—three of them being Government and the other two privately-managed. The rate of twinning works out to 12.75 per thousand births for this decade or one twin birth for every 78.6 births. This figure is based on a total of 255 thousand births. If figures for earlier years are also taken into consideration, we get a rate of 12.70 per thousand or one twin birth for 78.7 births. This figure covers 371 thousand births, and is for the period 1941–58. Comparative rates for the five hospitals range from 14.5 per 1000 to 8.7 per 1000. Further analysis relating to the age of the mother, and parity on twinning, nature of twinning etc., are in progress.

21. The Process of Urbanization in Andhra Pradesh

V. V. B. Rao and R. S. S. Sarma, Bombay

An attempt is made in this paper to study the process of urbanization during the period 1901–1961 in Andhra Pradesh. The following conclusions have been reached :—

Rapid industralization has not set in for Andhra Pradesh and the process of urbanization has received a spurt only in recent decades. The pattern of urbanization

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observed till 1961 can hardly be described by a logistic approximation. An exponential trend is found to be close to the observed pattern of urbanization.

The State of Andhra Pradesh is still predominantly agricultural. A trend towards urbanization in the beginning of the century was checked somewhat between 1911 and 1921 by the floods and epidemics during the period in the cities of Hyderabad and Warangal.

The period 1941–1961 has seen the beginning in the process of urbanization accompanied by industralization. With the advancement of industries, urbanization in Andhra Pradesh can be expected to grow at a progressive rate in the coming two or three decades.

22. A new approximation to the true infant mortality rate

RANJAN KUMAR SOM, Calcutta

The comp ıtation of the true infant mortality rate (IMR) for the cohort of (live) births in a calendar year requires the tabulation of infant deaths by the calendar year of birth : this information is not often available, and even when available, can be obtained only after the passing of the next calendar year. In this paper, a new approximation to the true IMR has been proposed. This assumes the constancy (over time) of the ratio of the number of infant deaths in the next calendar year to that in the same calendar year as that of birth and has been seen to be better, on the criteria of (1) number of closest values; (2) average deviation; and (3) rootmean square deviation, than the other available approximations when applied to the Swedish data of 1914–45.

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SECTION OF PHYSICS

PRESIDENT: PROF VIKRAM A SARABHAI, M.A. (Cantab.), Ph.D.

Abstracts

1. On the Singlet→ Triplet Absorption in a few Polysubstituted Benzenes in the Vapour State

J. K. ROY and S. C. SIRKAR, Calcutta

The absorptio spectra in the near ultraviolet region of ortho-, meta- and para-fluorotoluene, *m*-chlorotoluene, 2,4-dichlorotoluene, and 3,4-dichlorotoluene in the vapour state and with a path length equivalent to about 7 mm of the liquids have been investigated and compared with those due to equivalent path lengths of the liquids. In the case of 2,4-dichlorotoluene and 3,4-dichlorotoluene the spectra have also been photographed with the vapours at about 205°C using a high dispersion spectragraph.

It has been observed that these vapours exhibit continuous absorption starting at different points in the region lying between 26000 cm^{-1} and 29000 cm^{-1} and increasing towards shorter wavelengths. When the vapours are liquefied the region of absorption shifts towards shorter wavelengths, the shift being larger for ortho compounds than for the para compounds, but the long wavelength limit in the spectra of the isomeric molecules in liquid state are almost identical. It has been found that the spectra due to the vapours at different temperatures are identical. These results have been discussed.

2. On the Electronic Spectra of 1,2,4-trimethylbenzene in the liquid and solid states

T. N. MISRA and A. K. CHAKRABORTY, Calcutta

The near ultraviolet absorption spectra of 1,2,4-trimethylbenzene in the liquid state and in the solid state at −180°C have been studied and the results have been compared with those for the substance in the vapour phase as reported by earlier workers. In the liquid state four broad bands are observed and the 0,0 band is at 36185 cm^{-1}, displaced by about 715 cm^{-1} towards red from that observed in the vapour phase. When the liquid is solidified and cooled to −180°C, the bands become sharper and seven prominent bands are clearly resolved. The strong 0,0 band is at 36368 cm^{-1} and thus on solidification and cooling to −180°C, the band system is shifted towards high energy region by about 183 cm^{-1} with respect to that in the liquid state. These results have been discussed in terms of influence of intermolecular field in the crystal lattice on the electronic energy states of the free molecule.

3. On the Raman Spectra of Acetylacetone in the Solid State at −180°C

M. MAZUMDER and S. B. ROY, Calcutta

The Raman spectrum of acetylacetone in the frozen state at −180°C has been photographed and compared with that of the liquid at about 30°C. It has been observed that the intensity of the line 1596 cm^{-1} compared to that of any other line

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in the region 1000–1400 cm^{-1} does not diminish very much with solidification of the substance and cooled down to −180°C. Also a sharp new Raman line of shift 53 cm^{-1} appears in the spectrum due to the solid at −180°C. It has been concluded that the origin of this new line is due to intermolecular vibration and probably dimers are formed in the solid state giving rise to such vibrations. It is further concluded that the structure of the molecule does not change appreciably with the change from the liquid to the solid state.

4. On the Electronic Spectra of Parabromophenol in different States

T. N. Misra and S. B. Banerjee, Calcutta

The ultraviolet absorption spectrum of *p*-bromophenol in the vapour state has been analysed, assuming the molecule to belong to the C_{2v} point group. The intense 0,0 band of the spectrum, which is due to an allowed $A_1 - B_1$ transition, is found to be at 34784 cm^{-1} and the observed frequencies are 259, 297, 528, 645, 732, 913, 1019, 1137, 1240 and 1542 cm^{-1} in the excited state and 288 and 322 cm^{-1} in the ground state. The main features of the absorption system have been discussed.

The spectra of the compound in the liquid state and in the solid state at room temperature and at −180°C consist of broad bands. The 0,0 band of the crystal at room temperature shows a red shift of 157 cm^{-1} with respect to that observed in the case of the vapour state, while with lowering of temperature of the crystal to −180°C only a negligible further shift is observed. These changes have been discussed in the light of the existing theories of interaction of molecules in the lattice.

5. Infra-red Spectrum of Solid SiF_4

V. Sethuraman, Bombay

Infra-red spectra of SiF_4 in the vapour phase at room temperature and the solid phase condensed on a KBr window at 77°K have been recorded in the 2.5 –25μ region. Changes in the spectra between the two phases have been studied.

After the condensate of SiF_4 is evaporated away, the KBr window is still coated with a white residue. The infra-red spectrum of the residue has been recorded at room temperature and at 77°K. Some of the peaks obtained agree with those of K_2SiF_6, indicating reaction with the window.

6. Spectroscopy of Trapped Radicals

S. L. N. G. Krishnamachari and S. R. Deshpande, Bombay

An apparatus has been assembled to trap free radicals at liquid nitrogen temperatures. The free radicals produced in a microwave discharge through ammonia vapour are condensed on a liquid nitrogen cooled pyrex glass surface. The condensed deposit gave a greenish glow. The conditions required for making the glow more intense and stay for longer times are being studied. The spectrum of this glow is being studied and will be presented.

7. The $^1I_6$ State of Pr^{3+} in $LaCl_3$ at 77°K

R. M. Agrawal, R. C. Naik and D. Ramakrishnan, Bombay

Single crystal of 5% Pr^{3+} in $LaCl_3$ has been grown by Stockbarger's method and its absorption spectra at 77°K have been recorded in the region λλ 4200 – 5400 A on

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a grating spectrograph having a dispersion of 5A/mm in the first order. Polarization of the absorption lines has also been obtained. Additional lines in the group arising from $^3H_4 \rightarrow {}^1I_6$ have been observed and are accounted for satisfactorily. One additional stark level in $^1I_6$ at 21407 cm^{-1} has been established. For a few lines the polarization results obtained here do not agree with those of previous workers.

8. An Ultra-Violet Selective Filter

M. N. Dixit, Bombay

A selective filter for the ultraviolet region, making use of the carbon bisulfide vapour absorption band between 3000 Å and 3300 Å is described.

The use of this filter in photographing certain P_2 bands in the fifth order of a 3.4 meter 30,000 lines/inch grating spectrograph without the overlapping orders is discussed.

9. Rotational Structure of the F–X Band System of the $Cu^{65}Cl^{35}$ Molecule

R. K. Asundi, J. K. Brody* and P. Ramakoteswara Rao, Bombay

The F–X band system of $Cu^{65}Cl^{35}$ (3700–4200 Å) obtained in emission has been photographed under high dispersion. Rotational structure of (3,0); (2,0); (1,0); (0,0); (0,1) and (0,2) bands of the system has been analyzed. The electronic transition involved is shown to be $^1\pi - {}^1\Sigma$. The Λ-type doubling in the $^1\pi$ state is found to be negligible.

The principal molecular constants obtained are as follows (Cm^{-1}) units):

$F\ ^1\pi$ State $T_e = 25285.30$; $B_e = 0.1608$; $\alpha_e = 9.1 \times 10^{-4}$

$\omega_e = 384.94$; $\omega_e X_e = 1.65$

$X\ ^1\Sigma$ State $B_e = 0.1765$; $\alpha_e = 10.0 \times 10^{-4}$; $D_0 = 1.3 \times 10^{-7}$;

$\omega_e = 415.29$; $\omega_e X_e = 1.58$

10. On the Optical Absorption Spectra of $Ni^{2+} . 6H_2O$ Complex in Crystals

R. Chatterjee, Calcutta

The ligand field theory is applied to explain the optical absorption spectra of Ni^{2+} complex ion. To explain all the bands and lines of Ni^{2+} ion, an orthorhombic field superposed on cubic field is assumed. Calculation of the energy matrix for d^8 electron configuration in cubic field is performed by means of Tanabe and Sugano's method. A good agreement is obtained between our theoretical results with the experimental results of Hartmann and Muller (1958) which the latter authors themselves could not fully explain. Moreover, we have worked out a complete theory of the susceptibility and magnetic anisotropy of Ni^{2+} ion in an orthorhombic field and found good agreement with the experimental values, using the cubic and orthorhombic field parameters same as in case of optical absorption.

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11. A Modification of the R-K-R Method of Constructing the 'True' Potential Energy Curves of Diatomic Molecules

N. L. Singh and D. C. Jain, Varanasi

A modification of the R-K-R method of constructing the 'true' potential energy curves of diatomic molecules has been suggested which simplifies the numerical work involved in the calculations to some extent. Following the method by Vanderslice, Mason, Maisch and Lippincott (1959, a) of introducing artificial discontinuities in the law of force, an artificial discontinuity is assumed at each vibrational level. The values of $(w_e)i$ and $(w_ex_e)_i$ are determined by solving the quadratic equations involving these and the corresponding vibrational terms, instead of the least square technique applied by them.

The method has been applied for calculating the 'true' potential energy curve of $C^3\pi_u$ state of N_2 molecule and it is found that the results compare well with the values obtained by Vanderslice, Mason and Lippincott (1959, b) which justifies the procedure adopted by us.

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12. On the Absorption Spectrum of *m*-Chlorophenol Vapour

N. L. Singh and B. R. Das, Varanasi

The absorption spectrum of *m*-chlorophenol in vapour state has been studied in detail. The spectrum lies in the region 2800–2550 Å and consists of more than 200 bands which have been analysed in terms of 4 ground state and 12 excited state frequencies. The results are found to agree well with known Raman data.

13. On the Emission Spectrum of *p*-Tolunitrile

N. L. Singh and R. N. Singh, Varanasi

The near ultra-violet emission spectrum of *p*-tolunitrile was obtained by means of an uncondensed transformer discharge through flowering vapour of the substance. The whole spectrum consists of nearly 21 bands in the region 2755–3150 Å superposed on a continuum beginning at about 2760 Å and extending to beyond 3800 Å with maximum intensity in the middle portion of the spectrum. A tentative vibrational analysis of the spectrum is proposed in terms of four ground state frequencies. Except one, the rest three suggested ground state frequencies find support from the Raman data.

14. On Fluorescence Spectrum of Phenol Vapour

N. L. Singh and Satya Prakash, Varanasi

The near ultra-violet fluorescence spectrum of Phenol vapour has been obtained of the Hilger Medium Quartz Spectrograph. It consists of nearly 70 bands with a

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weak continuum superposed over the entire spectrum. The exciting source had been a condensed iron spark. A tentative analysis is made on the basis of fundamental ground state vibrations 241, 526, 624, 812, 828, 1001, 1256 and 1598. These agree well with Raman data.

15. On the Emission Spectrum of Aniline

R. J. Singh, Varanasi

The emission spectrum of aniline has been obtained in an uncondensed transformer discharge through the flowing vapour of the substance. There are nearly 130 bands in the region (2859 Å–3255 Å) superposed on a continiuum starting from about 2800 Å and extending upto 4000 Å. The observed ground state frequencies of 235, 378, 528, 621, 826, 994 and 1031 cm^{-1} are correlated with the symmetric Raman frequencies 234, 386, 534, 615, 817, 994, 1030 cm^{-1} respectively. Excited state frequencies 62, 291, 340, 493 cm^{-1} have been obtained as also observed by Ginsberg and Matsen[2] in their absorption work.

A detailed analysis will be published elsewhere.

16. Near U.V. Absorption Spectra of 1,4,-Naphthoquinone

R. S. Singh and S. C. Srivastava, Varanasi

The absorption spectra of 1,4-Naphthoquinone in vapour phase has been studied in the near ultraviolet region with a view to study the perturbation in the quinonoid ring caused by the fused benzene ring. Various cell lengths at various temperatures were tried. With a cell of 100 cms at 105°C and a cell of 50 cms at 95°C two systems, one in the 3000–3500 Å region and the other in the 2250–2500 Å, develop respeetively. Both systems appear to be due to allowed ($\pi - \pi$) electronic transition from the gross structure of the bands, the 0,0 of the two systems being at 29404 cm^{-1} and 40599 cm^{-1} respectively.

As a result of the present investigation it is found that one of the transitions which should have been forbidden becomes allowed on account of the perturbation caused by the benzene ring. The definite assignments of the transition should await further work both theoretically and experimentally.

17. Intensity Measurements in Bands and Rotational Temperatures

M. I. Savadatti and N. T. Tawde, Dharwar

Rotational temperatures for $OH(^2\Sigma - ^2\pi)$, excited in the inner cones of methyl alcohol/air flames have been measured at various air/fuel ratios of combustible mixture. At these air/fuel ratios, intensity of OH (0–0) at the R_1 head (B) was measured simultaneously with the corresponding integrated intensity (A). The ratio A/B was found to follow the rotational temperature (T) of OH. Further the graph of log (A/B) plotted against 1/T gave a straight line. This relationship is discussed with regard to the correction to be applied to band head intensities.

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18. Studies in Nitrogen Afterglow

B. G. Jyoti and N. R. Tawde, Dharwar

Nitrogen afterglow was produced by passing a condensed discharge through nitrogen. Intensities of (a) the afterglow and of (b) the discharge are measured by varying (1) the pressure of N_2, (2) the rate of flow of N_2 and (3) the voltage at which the discharge is maintained. It is found that while the intensity of the afterglow is proportional to the cube of the pressure, that of the discharge proper decreases as logarithm of pressure. The effect of rate of flow on intensity of the discharge is similar to the effect of pressure, whereas the same on the intensity of the afterglow is somewhat different from that of pressure. As voltage is increased the afterglow intensity increases, passes through a maximum and then begins to decrease, whereas the discharge intensity continuously increases with voltage.

The afterglow is characterised by selection of the IP bands of N_2 and the discharge by the N_2 IP, IIP and the First negative (N_2^+) bands. The first negative (N_2^+) bands have been found to be more intense in a discharge through flowing gas than through trapped gas. It is also observed that N_2^+ bands in the flowing gas condition gain brightness with increasing pressure and rate of flow. However, such is not the case with IP and IIP. Their behaviour is contrary. With voltage increase all the bands of the discharge gain in intensity. These observations are discussed in the light of the mechanism of the nitrogen afterglow.

19. The Oscillator Strength and Transition Probabilities of the Schumann-Runge System of O_2

N. Srreedhara Murthy, Dharwar

The transition probabilities for the Schumann-Runge system of O_2 recently measured by Treanor and Wurster have been used to obtain an expression for the variation of electronic transition moment with inter-nuclear separation. With the use of this relation a new estimate of the oscillator strength has been made and critically discussed in terms of the available *f*-data for the system.

20. Saturation Curves for KCl : Tl Luminescence

R. V. Joshi, Baroda

The saturation curves for U.V. and visible luminescence were studied in the case of KCl : Tl phosphors. The results obtained indicate that there is difference in the filling up of the ultraviolet and visible traps. This difference can be explained if Tl^+ centres responsible for ultraviolet and visible emission are assumed to be different.

21. Effects of Reactor Radiations on Optical Spectra of Caesium Uranyl Nitrate and Uranyl Nitrate-hexahydrate

R. M. Dixit, Bombay

The effects of reactor radiations on optical spectra of caesium uranyl nitrate and uranyl nitrate hexahydrate are studied. The spectra of the three hour irradiated

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caesium salt indicate absence of the characteristic absorption and fluorescence of UO_2^{++} ion. Instead of fluorescence a new set of bands appears which closely resembles a portion of UO_2^{++} spectrum in hexahydrated uranyl nitrate.

A set of bands which are attributable to the impurity in caesium salt get particularly enhanced in irradiation.

Uranyl nitrate hexahydrate shows no change in its spectra after irradiation for a period of one hour.

22. An Observation in maximising the Output of a Crystal Detector in Microwave Measurements

P. C. Mahendru and R. Parshad, New Delhi

It has been observed that the pick-up by a crystal detector housed in a detector mount under matched conditions (i.e., about unity standing wave ratio) is a function of the placing of the crystal in the detector mount. As the crystal is displaced, maxima and minima of detected output appear. The difference between the two power levels is about three *db*.

The above fact can be made use of in obtaining increased sensitivity in microwave measurements.

The exact cause of the effect observed is not clear, but phenomenologically it appears that the crystal mounting inside the wave-guide system produces higher order modes which alter the straight TE_{01} field (at the crystal itself) to a varying electric field along the crystal length, and at right angles to the broad face of the wave-guide. The placing of the point contact of the crystal with respect to this field variation would determine relative magnitude of the power output.

23. Absorption of Microwaves of 3cm Wave-length in Anisole and its Solutions

T. J. Bhattacharyya and K. K. Deb, Calcutta

The absorption of microwaves of wave length 3 cm in pure anisole and its solutions of different concentrations in CCl_4 and hexane have been studied. The pure liquid shows the maximum absorption at 4°C and in the case of solutions in CCl_4 or hexane the maximum of absorption is found to occur at lower temperatures. The radius of the rotor as calculated from the Debye's formula was found to be 1.65 Å approximately and it has been pointed out that the OCH_3 group may be identified as the rotor in the present case.

Soild State Physics and Crystalography

24. Structure of Etch Pits on Calcite

A. R. Patel and K. N. Goswami, Vallabh Vidyanagar

Calcite cleavages are etched with citric acid. Careful observations have revealed that though the individual isolated pits have the same shape and size, their structures

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differ. Approximately boat shaped pits having their 'keel' rectilinear and having their 'keel' bent in one direction or the other at the nose and thus having different structures, are observed. The bent 'keel' gives the appearance of a 'beak'. By etching matched cleavage faces with the same etchant and with different etchants it has been established that pits of one structure on one face correspond to pits of the same structure on the matched face. It has also been shown that structures described above persist on continued etching. The dynamic etching of calcite cleavages in addition to the usual pits and the pits of the above structures have revealed the pits of terraced structures. These terraced pits are found to have point as well as flat bottoms. Correspondence of the terraced pits on matched faces has been established. It is shown that the method of etch has nothing to do with the terracing of the pits. From the persistance of the structures of the pits on continued etching and their matching on oppositely matched cleavage faces when etched with different etchant, it is conjectured that the different structures may be attributed to different nature of defects in the crystal lattice at which such pits are nucleated.

25. Etching of Synthetic Mica

Dr. A. R. Patel and S. Ramanathan, Vallabh Vidyanagar

The etch patterns produced by hydrofluoric acid on synthetic mica have been studied optically. It consists of only localised individual isolated pits. The usual random distribution of small micropits observed on natural micas along with the individual isolated pits are not observed in the present investigation and this may be attributed due to the absence of impurity atoms in the lattice of the crystal. It is observed that the shape, size and orientation of the pits is not uniform throughout the pattern and this may be attributed due to the inhomogeneous structure of the crystal face. By etching oppositely matched cleavage faces one to one correspondence between the localization of the individual isolated pits has been established. Thin flakes of mica have been etched. It has been shown that considerable amount of correspondence exists in the etch patterns on the opposite faces of a thin flake. The etch patterns on the opposite faces show a considerable amount of displacement which is not uniform throughout the pattern. The displacement has been explained by postulating the existence of included linear dislocations in the body of the crystal. The implications are discussed. On some samples triangular pits are observed having basal extension. These basal extensions are shown to be air wedges within the body of the crystal.

26. Etch-pits in crystals and dislocations

G. C. Triguhnayat, Delhi

The result of delicate etching with water vapour upon cadmium iodide crystals exhibiting growth spirals on their surfaces are described and discussed. The creation of very symmetrical small hexagonal pits lends strong support to the idea that etch-pits are preferentially formed at the sites of dislocations, and thus justifies the use of etching techniques in revealing boundaries of dislocations on crystal surfaces in the study of problems of plastic deformation. A tentative explanation for how the presence of a dislocation induces a local dissolution of the crystal, is suggested on the basis of the fact that the strain energy of lattice is high around a dislocation.

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27. Optical Study on Cleavage and Etched Survfaces of Fluorite

J. R. Pandya and N. S. Pandya, Baroda

Freshly cleaved surfaces of Fluorite are examined and then etched with various acids. The surface examination is done with high resolution microscopy and multiple beam interferometry. Triangular etch pits oriented differently which turn into block patterns on prolonged etching have been observed. The cleavage lines shift and the pits remain stationary. The crystal plates were bent and then etched. The results are discussed on the movement of dislocations.

28. Hysteresis Loop Tracer for the Study of Ferromagnetic Properties over wide Ranges of Temperature

A. K. Mukherjee and N. G. Sutradhar, Calcutta

Quite a number of semi-conducting samples obtained from natural sources or prepared artificially are found to be ferromagnetic. With a view to study the role of the free electrons responsible for semi-conduction on the ferro-magnetic behaviour of such samples, a 50 c.p.s. hysteresis loop tracer has been designed which enables us to study single crystals of these samples at different temperatures both high and low.

Here the sample placed in an a.c. magnetic field induces a voltage, in a previously balanced pick up coil surrounding it, proportional to the rate of variation of the intrinsic induction in the sample. Another coil placed in the same field H picks up a voltage proportional to dH/dt. Both are suitably amplified, integrated and fed into the oscilloscope to get the desired pattern.

Measurements can be made of intrinsic coercive force, residual induction of the sample, the normal permeability and the normal induction and can be studied with respect to the field.

29. A Method of obtaining True Values of Electrical and Magnetic Properties of perfect Graphite Crystals from a Study of these with Defective Ones

R. Bhattacharya, Calcutta

It has been shown from X-ray observations that in all natural crystals of graphite, descrete misalignments between the different crystals blocks are inevitably present and these are further enhanced by the purificatory treatments which are usually undertaken before the actual measurements of any of its electronic properties. It has also been shown that above-mentioned enhancement of the defects produce appreciable change in its electrical and magnetic properties. None of the existing measurements of these properties which are with purified natural crystals of graphite therefore represent the true values for perfect crystals and hence can be discussed in relation to any of the proposed theories. From a measurement of the variation of intensity along the extension of the X-ray spots observed in a rotation photograph, a method has been suggested with which the above-mentioned true values can be obtained. The present paper gives an account of these.

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30. Setting up of a Paramagnetic Resonance Spectrometer for the Study of Magnetic Behaviour of Crystals

U. S. Ghose and R. N. Bagchi, Calcutta

For various studies on magnetic behaviour and structure of crystals, a paramagnetic resonance spectrometer is considered to be one of the most important tools. A transmission type electron paramagnetic resonance spectrometer operating at 3.2 cm wavelength has been set up in this laboratory. For study at different temperatures a cryostat has been designed by us to suit the purpose of varying the temperature down to well below 90°K. Arrangements have been made for investigations along different axes of a single crystal. In order to measure the magnetic field as accurately as possible, a proton resonance fluxmeter designed mostly after Knocble and Hahn has been constructed. The apparatus has been standardised with D.P.P.H.

Theoretical investigations on the susceptibility, g-values and the nature of crystalline electric fields of Fe^{++}, Ti^{+++}, Co^{++}, V^{+++} and Ni^{++} have been carried on by Bose, Chakravarty and Chatterjee of this laboratory. The resonance spectrometer will enable us to test many of the conciusions, derived in their theoretical investigations. X-irradiated single crystals of alkalihalides having defect centres (e.g., KCl containing TlCl) have been prepared in this laboratory by S. Dutta. Nature and concentration of colour centres and g-values of such crystals can also be studied with this spectrometer. Fairly detailed account of the apparatus is presented.

31. Dielectric Behaviour of Some Bentonites

Sm. Sabita Ghosh, Calcutta

The dielectric behaviour of some bentonites of different sources was studied for frequencies ranging from 100 Kc/S to 4 Mc/s. The Bentonites from Germany (Hanover) and England and from Assam, Kashmir and Rajasthan in India were taken in powder form and sieved through 200 mesh per sq. inch. The samples are packed between brass electrodes of the experimental condenser. The loss-tangent (tan δ), ε'', ε' and relaxation time τ were then measured within the said frequency range with the help of a precision type Q-meter. In the tan δ vs. frequency and ε'' vs. frequency curves for all the studied samples, maxima were observed. The values of the relaxation time (τ) were determined from tan δ vs. frequency curves by the relation $\tau = \frac{1}{2\pi f_{max}}$. The observed values of the frequency for maximum absorption and the computed values of the relaxation time for the different samples of Bentonite were as follows :

Sources	f_{max}(Kc/S)	τ(Second)
Germany (Hanover)	240.0	6.6×10^{-4}
England	167.0	9.5×10^{-4}
Assam	240.0	6.6×10^{-4}
Kashmir	240.0	6.6×10^{-4}
Rajasthan	300.0	5.3×10^{-4}

The method of measurements and the experimental results are discussed.

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32. Effect of Assymmetry of Shape on the Magnetic Anisotropy of Crystals

MANJU MAZUMDAR, Calcutta

In order to eliminate the effects of asymmetry of shape of magnetically anisotropic crystals, particularly those with low anisotropy, cylinders (or spheres) are usually ground out of the crystals—a procedure open to objection in case of hygroscopic or deliquescent crystals, and generally, because of the possibility of contamination. Efforts were, therefore, made to estimate the shape effects and apply them in the case of actual crystals which could then be used in their natural form.

In order to correct for the shape effects, isotropic crystals of several alums and alkali halides (which have no magnetic anisotropy of their own) were chosen and rectangular plates of different dimensions, l, b, and h [where l = length, b = breadth and h = height when the plate is suspended vertically in any particular experiment] were ground, using a crystal grinding apparatus set up for the purpose. The plates were suspended with different edges vertical and the apparent magnetic anisotropy $\Delta\chi/\chi$ (χ-being the magnetic susceptibility) determined with the help of an improved form of apparatus based on the well-known Krishnan method. The results indicate some interesting relationship between $\Delta\chi/\chi$ and l, b and h, for example, $\Delta\chi/\chi$ increases with decreasing b; l and h remaining constant, and $\Delta\chi/\chi$ becomes zero for $l = b$. Again $\Delta\chi/\chi$ decreases with increasing, h, l and b remaining constant, and becomes zero for $h \to \infty$.

From the observed results and by graphical interpolation it is possible to apply suitable correction terms within certain experimental limits for normally available crystals.

33. Surface Self-Diffusion of Iodide Ions in Films Adsorbed on Metals

H. J. ARNIKAR and O. P. MEHTA, Varanasi

Characteristic discontinuities and sudden 'downpours' observed in the time-rate of adsorption of *labelled* I^- ions on metals and marked deviations from the effective partition coefficient ratio in its adsorption from a two phase (water-CCl_4) adsorbate system, showed the occurrence of measurable surface mobility in the adsorbed layers. Results are reported for the measurement of surface self-diffusion coefficient (D^*) of I^- ions for its uni-dimensional diffusion in mono- and multilayers of the adatoms under conditions of zero concentration gradient of the total I^- (labelled and unlabelled). Data are presented for D^* for I^- ions on copper and aluminium for various temperatures in the range 150–250°C. The faster surface diffusion in multi-compared with monolayers is discussed in terms of corresponding entropy and heat of activation.

34. Temperature Variation of the Absolute Photoelastic Constants of Potassium Chloride and Potassium Bromide

K. V. KRISHNA RAO and V. G. KRISHNA MURTY, Hyderabad

This paper describes a method of studying the temperature variation of the absolute photoelastic constants of cubic crystals. The method consists in evaluating the differential stress-optical constants by Filon's method, the ratio of the strain-optical constants by an ultrasonic method and combining these data to obtain the absolute

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strain-optical constants. A number of cubic crystals have been studied by this method in the temperature range 30°C to 400°C. The results for potassium chloride and potassium bromide are reported here. It has been found that P_{11} and P_{12} for both potassium chloride and potassium bromide and P_{44} for potassium bromide first increase with the rise of temperature and then decrease whereas p_{44} for potassium chloride steadily increases with temperature.

35. Mixed Layer Mica-Vermiculite-Chlorite Structures

BIBHUTI MUKHERJEE, Calcutta

Gruner's idea of the distortion of structural planes of vermiculite by grinding for unsatisfactory powder photographs has been found untenable in the present investigation. The lattice dimensions of a true vermiculite from Ajmer-Marwar were determined as, $a_0 = 5.24 \pm 0.02$ Å, $b_0 = 9.17 \pm 0.02$ Å, $c_0 = 28.60 \pm 0.05$ Å, $\beta = 94°36' \pm 24'$, the monoclinic angle being slightly larger than the angle obtained by Hendricks and Jefferson. The intensity relations between the different reflections in the powder photographs of this typical vermiculite are in good agreement with the relative values of structure factors determined by Hendricks *et al.*

Large groups of vermiculite layers and small groups of mica layers occur as distinct units along with hydrobiotite units in some specimens of vermiculite, but the specific mutual orientation of the adjacent layers of mica is not evident. The proportion of layers in the mixed vermiculite-mica, determined from the graphs of Brown and MacEwan (1951), may be expressed as an interstratification of alternate layers of units of vermiculite and mica, and of three units of vermiculite with two units of mica making up a large part of the specimens. The stronger reflection of hydrobiotite (001_y) compared to (008) of vermiculite and (006) of mica has been attributed to the change of phase between reflections from successive layers of the larger units of this mixed structure.

Interstratification of layers of units of vermiculite and chlorite in almost monomolecular layers with the probable reflection of this mixed structure, and more complex mixed-layer structures of vermiculite-chlorite and *K*-saturated vermiculite have been discussed.

36. Tentative Molecular Structure of Tetramethyl Diphosphine Disulphide

S. N. DUTTA, Lucknow

In view of the recent interest in the chemistry of Organophosphorous Compounds, the structural investigation of Tetraethyl diphosphine disulphide was undertaken as an extension of the study on Tetraethyl diphosphine disulphide (see Dutta, S. N. and Woolfson, M. M., Acta Cryst., 14, 178, 1961).

Crystals of $(CH_3)_4P_2S_2$ were in the form of colourless needles (m.p. 205–13°). Oscillation and Weissenberg photographs showed the unit cell to be monoclinic with the following dimensions :—

$$a = 19.20, \quad b = 10.88, \quad c = 7.00 \text{ Å}; \quad \beta = 94.5°$$

The crystals were invariably twinned across the plate face (100). The space group is somewhat ambiguous; it is either *C*2, *Cm*, or *C*2/*m* and contains 6 molecules

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per unit cell. However, the $hk0$ reflexions showed a very distinctive feature : reflexion types $hk0$ vanished unless $h = 3n$ where n is an integer. This implied that for the [001] projection, the pseudo-cell was effectively a third of the real cell and at the same time centered.

A partially sharpened Patterson synthesis was employed for finding a rough picture of the plausible 'molecular motif'. The interpretation of the Patterson map, supplemented by a simplified fly's eye procedure, gave the molecule a *trans*—form. With this trial model the structure factors were evaluated to obtain the likely phases; the latter were then employed to obtain the electron density distribution for the [001] projection. An examination of the resulting Fourier map showed that, for a first map, the peak resolution and heights were resonably satisfactory. The over all structure factor agreement was fairly good; the agreement residual at this stage was 25% (including the accidental absences as well). Although the complete structure has not been unravelled so far, the preliminary X-ray analysis seems to suggest that the molecule of $(CH_3)_4P_2S_2$ has a *trans*-form and is probably centrosymmetrical.

37. X-ray Powder analysis of Diphenylamine

J. Dhar and S. N. Mitra, Dhanbad

The diphenylamine crystal was studied by the well-known powder method of analysis. The observed spacings of the lines in the powder photograph were found in close agreement with the spacings calculated on the basis of the cell-dimensions reported earlier.

38. Small angle X-ray measurements on Alkali treated Nagel keratin

Dr. T. Ratho, Cuttack

The small angle scattering camera after Kratky capable of high pefrcession measurements was used in the present investigation on Keratin treated as a densely packed phaser system. The sample was irradiated with copper $k\alpha$ radiation obtained from a Siemen's apparatus by the well known crystal monochromator after Jahanson Guinier. The scattering curve was obtained photographically and following the procedure of Guinier the radius of inertia of the crossection and the thickness factor were obtained from the Log $(Im)-m^2$ and the Log $(Im^2)-m^2$ curves rsespectively. However for the calculation of radius of inertia the scattering elements were treated as road like particles and for the estimation of the thickness factor they are taken as thin sheats. The curve representing the Guinier plotting for the crossections factor breaks up distinctly into two parts leading to two values of the radius of inertia as 26 Å and 78.5 Å respectively. Similarly the thickness factor curve gives 36 Å and 115 Å as the values for the thickness factor. It is thus seen that a new smallest layer of thickness 36 Å which is exactly half the smallest layer of 72 Å reported previously by Dr. Skoda and others is obtained.

39. An X-ray Study of Fluoranthene

J. Dhar and S. N. Mitra, Dhanbad

The fluoranthene crystals were studied by the rotating-crystal as well as by the powder methods of analysis. The X-ray study of the fluoranthene crystal by the

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powder method supports Krishnan and Banerjee in their view-point that the crystal data given in Groth's Chemisho Krystallographie under fluoranthene refer to the compound $C_{16}H_{10}$.

From the X-ray measurements the cell-dimensions of the fluoranthene crystal were obtained as $a = 18.41$ Å; $b = 6.22$ Å; $c = 37.89$ Å and $\beta = 97°42'$. Hence the axial ratio is 2.959 : 1 : 6.091. The number of molecules per unit cell comes out to be 16.

40. Changes in Crystal Structure of $Cu[NH_4SO_4]_2\ 6H_2O$ with Temperature

Gouri Bhowmik, Calcutta

Thermal dehydration curve of $Cu(NH_4SO_4)_26H_2O$ showed three distinct steps at 65°C, 110°C and 158°C corresponding to loss of 4, $1\frac{1}{2}$ and $\frac{1}{2}$ molecules of water respectively per formula unit. X-ray powder photographs of the first two dehydrated phases were taken, and the crystal structure determined. It is found that the monoclinic $Cu(NH_4SO_4)_26H_2O$ first changes to an orthorhombic dihydrate form at 65°C, then to a monoclinic hemihydrate at 110°C, and finally to the anhydrous phase whose structure is yet to be determined.

41. A Method of Determining the Nature of the Intensity Distribution in Power Diffraction lines

G. B. Mitra and N. C. Halder, Kharagpur

Careful experimental investigation has shown that the intensity distribution in powder diffraction lines is more or less of a Gaussian form. But it has not been possible to determine whether it is of the Gauss or Cauchy type or a combination of both. On the other hand, the importance of such knowledge in particle size determination for instance is immense. In the present work it has been shown that although the experimental line profile can not be made to fit in with a function $p(z)$ where $p(z)$ is either the Gauss or Cauchy or a convolution of the two, because the difference between numerical curves describing them is too slight to be distinguished, a function $N(z) = \int_0^z p(z)dz$ gives quite distinguishable results. Analytical forms of $N(z)$ for the three cases have been derived. A method of experimental determination of $M(Z)$ has been described.

Gas and Ionic Theory etc.

42. Theory and Performance of Thermal Diffusion Column

S. C. Saxena and S. Raman, Bombay

A general theory of thermal diffusion column filled with the isotopes of a monatomic gas and interacting according to an inverse power model is developed. The theory of Furry and Jones valid for maxwellian gas molecules follow as a particular case of the present work. The available experimental column data are compared with the predicted values of this theory. Recent calculations of Mc Inteer and Reisfeld

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valid for molecules which interact according to the familiar Lennard-Jones (12–6) potential are also considered. In general, only a poor quantitative agreement is obtained between theory and experiment. The theory also completely fails in its present form for isotopes of polyatomic gases and for binary mixtures. It, however, successfully predicts a qualitative form for the pressure dependence of the over-all separation factor in a thermal diffusion column.

43. Thermal diffusion of Binary Gas Mixtures. II

S. C. Saxena and S. M. Dave, Bombay

Rigorous theoretical formulas according to Chapman and Cowling, and Kihara approximation schemes have been derived for the Thermal diffusion factor of such binary mixtures where the lighter component is in trace.

These formulas are further simplified by expanding in powers of the ratio of molecular masses. The latter expressions are simpler and preferable for numerical computation. Sample numerical calculations reveal that the convergence of the theoretical formulas for this case is poorer as compared to the other end of the composition range, the magnitude depends upon the system and on the temperature range.

44. Equilibrium Properties of Polar Gases. I. Second Virial Coefficient

S. C. Saxena and K. M. Joshi, Bombay

The theoretical expressions for the second virial coefficient, $B(T)$, are derived from the (18-6-3) Stockmayer potential

$$\phi(r) = 4\varepsilon \left[\left(\frac{\sigma}{r}\right)^{18} - \left(\frac{\sigma}{r}\right)^{6}\right] - \frac{\mu^2}{r^3} g(\theta_1, \theta_2, \phi),$$

where $g\ (\theta_2, \theta_2, \phi) = 2\ \mathrm{Cos}\,\theta_1\ \mathrm{Cos}\,\theta_2 - \mathrm{Sin}\,\theta_1\ \mathrm{Sin}\,\theta_2 \mathrm{Cos}\,\phi$, and also according to the (28-7-3) potential. Reduced virial coefficient is tabulated for the former potential. The experimental data of $B(T)$ are interpreted for a number of gases. The potential parameters are reasonable and reproduce the $B(T)$ data within the limits of experimental errors. The point dipole polarizable model is also considered.

45. Two Body Correlation Function in Gases

S. L. Deo and B. Deo, Cuttack

Starting with the exact equations of kinetic theory for distribution functions and treating inverse density and potential as perturbations, it is found that all many particle distribution functions can be generated by a one particle distribution function and a two body correlation function. It is further noted that even in the zeroeth order of approximation, the correlation function has a non-vanishing value. This is explicitely evaluated for a Maxwellian distribution function and is found to be oscillatory for some two body potentials.

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46. 'Correlationless' Kinetic Equation for Gases

R. K. Satpadhy, Bhubaneswar

An equation very much similar to Plasma equation without collision is deduced from the general kinetic equation under some approximation for neutral gas molecules. This equation is studied to obtain oscillatory solution. It is found that there exists solutions usually under Landau damping. A special distribution function is used to calculate exactly the velocity of propagation and Landau damping. An application to a delta function potential is also made. Typical conditions for growing waves and decaying waves and for infinity and zero damping cases are considered.

47. Study of Ionised Gases by a Radiofrequency Probe

S. N. Sen and A. K. Ghosh, Calcutta

A radio frequency signal (frequency 2.2 Mc/Sec) has been used as a probe to investigate the characteristics of an electrical discharge in air and in mercury vapour the discharge being excited by a transformer. An alternative method has been employed to measure the radio-frequency conductivity of the ionized gas at various pressures of the gas from 5×10^{-3} mm to 1 mm of Hg and also for various values to the discharge current. The variation of conductivity with pressure conforms to the theoretical deduction and various parameters such as electron concentration per unit volume, the random velocity and the electron temperature have been calculated. The variation of conductivity with discharge current shows that rise of electron concentration with current is not strictly linear and attains a saturation value when the current exceeds a certain minimum value determined by the pressure at which the observation is being carried out.

48. Influence of Ionic Currents on Heat-transfer in Liquids

R. G. Edkie, R. D. Rao and D. V. Gogate, Baroda

The phenomenon of heat transfer between an electrically heated wire and a liquid in which the wire is placed is studied and the variation of heat transfer coefficient with change in the value of $\Delta\tau$ (excess of temperature of the wire over that of the surrounding liquid) is determined. Ionic currents are then produced in the liquid by means of electrolytic dissociation and their effect on heat transfer is carefully noted. It is found that the value of heat transfer coefficient undergoes peculiar variations with regular increase in the strength of the ionic current. A detailed investigation of the changes in the heat transfer coefficient with change in the strength of the ionic current is described.

49. Effect of Irradiation on the Peak and Average value of the Current in an Electrodeless Discharge

M. G. Kelkar, Amravati

Observations of the effect of irradiation with visible light on the peak and average value of the current in an ozoniser discharge, containing air at low pressure (2–10 m.m.Hg.) are reported. It is observed that $\%\Delta i$ is maximum in both cases at the

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threshold potential *Vm.* (r.m.s. value of the breakdown voltage). Its magnitude, however, is large in the peak current and is perceptible in the entire potential range investigated. (~3 to 4 times *Vm*). In the average current the effect becomes insignificant at high potentials.

The results are explained on the basis of the oscillographic observation of the preferential suppression of the first large current pulse in each half cycle on irradiation. The progressive decrease of $\%\Delta i$ in the peak value is due to a corresponding reduction in the "active time interval" (when light is effective in its action of removing some of the loosely bound electrons from the momentary cathode) between successive half cycles. Since the smaller pulses are not affected by light $\%\Delta i$ in the average value of the current is small and almost vanishes with considerable increase in their number at higher potentials.

50. Heat of Mixing and Ultrasonic Velocity in Liquid Binary Mixtures

Prof. S. K. K. Jatkar and M. V. Kaulgud, Poona

The negative velocity deviations in eighteen polar in non-polar binary mixtures have been correlated with heat of mixing using the Hildebrand' solubility parameter equation. For a given polar solute in different nonpolar media the velocity deviation is more, the more the difference in solubility parameters of the components. For different polar solutes in a given solvent the velocity deviations decrease the more the difference in solubility parameters.

51. Measurement of the Thermal Conductivity of Chemically Reacting Gas Mixtures

P. K. Chakraborti, Calcutta

The thermal conductivity of dissociating N_2O_4 involving both the reactons $N_2O_4 \rightleftharpoons 2NO_2$ and $2NO_2 \rightleftharpoons 2NO+O_2$ has been measured between 100°C and 200°C and below a pressure of one atmosphere, using the absolute hot wire method. The results are, however, generally not in good agreement with the values calculated on the assumption of local chemical equilibrium. Various reasons for this discrepancy have been discussed.

52. Studies on Mutual Diffusion of Polar-nonpolar Gax Mixtures

B. N. Srivastava and I. B. Srivastava, Calcutta

The two-bulb technique of Ney and Armistead was employed for the measurement of the diffusion coefficients of mixtures of ammonia with argon and krypton in the temperature range −20°C to 60°C. Diffusion was allowed to take place through a precision capillary tube connecting the two diffusion bulbs and a previously calibrated thermal conductivity analyser was used for analysing the gas samples at different times.

A least square method was followed for determining the unlike interaction parameters from the experimental D_{12} values at different temperatures, on the Lennard-Jones (12 : 6) potential,

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The combination rules for such systems and the force constants of pure components were also used for calculating the unlike interaction parameters. Both the sets of parameters were used for calculating the diffusion coefficients. A comparison between the observed and calculated D_{12} values indicates that the combination rules for polar-nonpolar interactions are reasonably satisfactory but not quite exact.

Meteorology Ionosphere

53. Further Observations on Dew and their Significance

B. Padmanabhamurty and V. P. Subrahmanya, Waltair

The influence of various meteorological factors responsible for the deposition, maintenance and dissipation of dew was studied. Occurrence of dew is seen to bear a consistently close relation to the depression of radiation—minimum temperature below dew-point—greater dew deposited as the difference increased. Curves showing hourly variation of dew and the influencing meteorological parameters clearly indicate an inverse relation between dew on the one hand and vapour pressure and wind speed on the other. The net outgoing radiation slightly increases until the time of dew formation when the latent heat released due to condensation reduces nocturnal cooling of the surface and in turn the net out-going radiation. Figures representing vapour pressure profiles on particular dew nights show the development of vapour pressure inversions or constancies following the onset of dew.

A comparative study of dew observations at Waltair and Poona shows that Waltair has maximum frequency of dew in winter while Poona records its maximum in autumn. Further, Waltair (coastal) is seen to register higher annual dew amounts than Poona (Hill) although Poona should record higher values according to Rosenan and Gilead. The topography and interior location of Poona are perhaps not able to counteract the low humidities of the winter air for greater dew deposits in this season.

Curves depicting the march of mean monthly number of dew nights and mean monthly dew amounts at the above two stations indicate the differences in their dew regime. They also point to the conclusion that at Waltair the maximum amount of monthly dew occurs in the month of maximum frequency of dew occurrence while at Poona the peaks show clear separation indicating that Poona has large number of dew nights with sparse amounts of dew.

54. Scattering of Light Signals in Foggy Weather

W. J. John, Kanpur

This paper discusses the apparent change in the colour of light signals in foggy weather due to scattering. Rayleigh's and Mie's theory of scattering by small particles are briefly discussed. The scattering coefficient varies as λ^n where $n = -4$ for particles much less than the wave length of light and it goes up to even $+2$ for water droplets of 2–3 μ size. The available data for the observed values of n for fogs vary from 0.3 to 1.3 generally.

The spectrophotometric curves of several blue green and red signal glasses have been studied. The paper discusses quantitatively the apparent change of colour of

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these glasses due to the colour temperature of the source and also due to scattering following Mie's theory outlines above. The maximum variation in colours and dominant wave length for $n = 1$ and $n = 2$ have been calculated and discussed.

The usual statement that the red signals should contain no shorter wave lengths whatever even to a small percentage is not borne out from the above calculations.

55. The Refractive Index and the Absorption Index of the Ionosphere

Y. S. N. Murty, Delhi and S. R. Khastgir, Calcutta

In the present paper, simple expressions for the refractive index and the absorption index of the Ionosphere have been obtained with the help of the expressions for the polarization parameters obtained earlier by the authors. To illustrate the application of the expressions, a set of values of the refractive index and the absorption index have been computed under specified conditions.

56. A Note on the Group Refractive Index of the Ionosphere for zero Collisional Frequency

S. R. Khastgir, Calcutta and Y. S. N. Murty, Delhi

In a previous paper (Jour. Atoms. & Terr. Physics, London. 21, 65, 1961) Murty and Khastgir obtained a general expression for the group refractive index of the ionosphere following the Appleton–Hartree formulae. In a recent paper by Unz (Jour. Atoms. & Terr. Physics, London, 20, 189, 1961) an expression was also worked out for zero collisional frequency. On obtaining the expression for the group refractive index of the ionosphere for zero collisions from our general expression, it is found that the expression is not the same as that given by Unz. In the present communication, attention has been directed to an algebraic misrepresentation in Unz's paper which is responsible for the difference in the expressions for the group refractive index of the ionosphere for zero collisional frequency obtained by us and by Unz.

Theoretical Physics

57. Mass Spectrum from Four-Boson Contact Interaction

B. Deo, Cuttack

Following the analysis of Nambu for four-fermion interactions an attempt is made to explore the possibility of a mass spectrum for a self-coupled complex scalar or pseudoscalar boson (spin zero) field. It is found that starting with a self-mass equation, self-consistency requires that there can be a bound state of zero mass only if a momentum dependent vertex function exists. The ratio of the cut-off mass to self-mass and the self-coupling parameter can then be uniquely fixed. The existence of this particle is assumed and the strength of its coupling with the massive particle is determined. All couplings turn out to be large.

It is further noted that there are two conditions for resonance scattering of mesons. They can be explained by assuming the existence of two highly unstable particles, 2.1 and 3.3 times heavier than the scattering particle. If the scattered particles are pions the above particles have masses round 565 and 995 electron masses. The existence of such particles have been postulated by many workers from time to time.

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58. Response Function of a Degenerate Electron Gas

P. Misra and D. Misra, Cuttack

The electrical behaviour of a homogeneous electron gas is best described by the "Response function" $K(\vec{\mathbf{k}}\omega)$ defined by the relation $J_\alpha(\vec{\mathbf{k}}\omega) = K_{\alpha\beta}\vec{\mathbf{k}}\omega)\ E_\beta(\vec{\mathbf{k}}\omega)$ which in space-time configuration becomes a non-local and a-causal relation $J_\alpha(\vec{\mathbf{r}}-t) = \int d\vec{\mathbf{r}}' \int_{-\infty}^{+\infty} dt'\ K_{\alpha\beta}(\vec{\mathbf{r}}-\vec{\mathbf{r}}', t-t')E_\beta(\vec{\mathbf{r}}'\ t')$ J and E being the current density and electric field respecstively and J and E their Fourier transforms. This function is analogous to the inverse of "Impedance" in electric circuits and determines how an electrical disturbance propagates in the electron gas and under what circumstances the disturbance becomes oscillatory. The expression for the energy loss and scattering of charged particles involve this response function. For these reasons the function is a very important parameter for an electron gas. So far, this function has been evaluated for an electron gas at absolute zero temperature. In this paper we have evaluated this function at temperatures in the neighbourhood of absolute zero temperature by using the Boltzman-Vlassov equations and Fermi-Dirac distribution law of electron energies. Causality condition has been invoked on $K_{\alpha\beta}(\vec{\mathbf{r}}-\vec{\mathbf{r}}, t-t')$ to make the current-Electric field relation causal. Conditions under which the electrical disturbance become oscillatory are discussed. It is found that these conditions are the dispersion formulae for the Plasma oscillations of the electron gas.

59. Unstable particle in a Soluble Relativisticq Quantum field theory

T. Pradhan, Cuttack

In the derivative coupling ($L' = \lambda\psi(x)r\mu\ \psi(x)\delta_\mu\ \phi(x)$) relativistic quantum field theory explicitly solved by the author[1] the Boson becomes unstable and decays into a Fermion-anti Fermion pair if its mass is greater than twice the Fermion mass. The formalism adopted for the stable particle case treated in reference[1] is not adequate under this circumstance and requires modification. The modified formalism is presented from which a self-consistent equation for the complex decay constant is obtained, the real part of which gives mass renormalisation and the immaginary part gives the decay constant.

60. Elastic Scattering of Fast Protons by Deformed Nucleus

N. C. Sil and S. K. Dutta, Calcutta

Recent experimental evidences such as the energy levels in rotational spectra and electric quadrupole moment, etc., indicate that the heavy nuclei in the region far removed from the closed shell configuration possess an appreciable spheroidal deformation. This deformation is expected to have a bearing on the results where

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[1]Proceedings of the Elementary Particles and High Energy Physics Symposium, New Delhi, December 1960.

Proceedings of the Indian Science Congress Association, Roorkee, January 1961.

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the effect of nuclear shape plays an important role; in this paper we propose to investigate that effect on the nuclear scattering. Here the elastic scattering cross section for fast protons by a semi-transparent, prolate spheroidal nucleus has been calculated after neglecting the effect of nuclear spin interaction. It is assumed that the electrostatic field of the nucleus is generated by a uniform distribution of electric charge within the nucleus. Apart from the coulomb potential (between the proton and the nucleus) there is a nuclear interaction which is represented by an optical model complex rectangular well potential with constant depth and sharp cut-off at the nuclear boundary. The elastic scattering amplitude is calculated by the Born approximation method. The case of 96 Mev proton scattering by tantalum ($A = 171$, $Z = 73$) has been numerically computed since it is found that tantalum has a large value of electric quadrupole moment and hence possesses an appreciable prolate spheroidal deformation. The computed results agree well with the experimental data.

61. Dependence of Møller Scattering on Initial and Final Polarisations of Electrons

D. Basu and S. Sarkar, Calcutta

A general expression has been derived for the Møller scattering of electrons in which the polarisation states of both the initial and final electrons are arbitrary. In a way we have generalised the expressions given by Ford and Mullin for the two special cases of (i) the variation of differential scattering cross section irrespective of polarisation on the nature of polarisation of the two initial electrons, and (ii) the variation of the nature of polarisation of one of the scattered electrons when one of the initial electron is longitudinally polarised and the other initial electron unpolarised. To have better understanding of the results the general expression which is very lengthy may be very much simplified if we consider special cases. In the centre of mass system we take the initial electrons to be polarised perpendicular to the plane of scattering and the final electrons to be longitudinally polarised, it is found that in the limit of very high energy of the electrons, the differential scattering cross section consists of terms depending on the initial polarisations, final polarisations and both, the term that depends on both the initial and final polarisations vanishes for $\theta = 0°$ and $90°$. We have also obtained a term proportional to the fourth power of mass. in addition to the terms obtained by Ford and Mullin for the case when the initial electrons are arbitrarily polarised and the scattered electrons are unpolarised.

62. The Quantum Nature of Charge

Dharani Dhar Das, Cuttack

An attempt has been made to give an explanation of the quantization of electric charge. It is well known that electric charges have quantum nature. A simple and semi-classical approach has been made to prove it. The proof is qualitative and non-rigorous. Electric charge 'q' will have electromagnetic field around it. The energy of this electromagnetic field is found out to be $\frac{q^2}{a}$ where 'a' is the radius of the charge. Since energy is quantized, it follows that charge should also be quantized. Since charge is a point and "radius of the charge" is rather meaningless, we interprete

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the radius as the uncertainty in the localization of the static charge. We proceed to associate a minimum momentum of the charge. By using de-Broglie relation one deduces that the charge $q = \pm n\sqrt{\hbar C_0}$ where n is an integer, $\hbar$ = Plank's constant/2π and C_0 = a constant introduced here which may be called "the charge constant". The positive minimum value of q is $\sqrt{\hbar C_0}$. From an appeal to the experiment one gets Co $= \frac{e^2}{\hbar} = \frac{C}{137}$ = velocity of light multiplied by the finestructure constant.

63. Lattice Thermal Conductivity at Low Temperatures

Bal Krishna Agarwal and G. S. Verma, Allahabad

The theoretical models of Callaway and Klemens are compared to the experimental results in (a) Silicon and Diamond, (b) Solidified Argon and Neon and (c) KCl and NaF. The three sources of scattering are postulated; phonon-phonon processes, isotopic point defect scattering and boundary scattering except in NaG where isotopic scattering is absent. Callaway model, in all cases, gives good fit and an excellent agreement is obtained for Diamond and solidified Argon and Neon. Casimir model for finding out the characteristic length for the boundary scattering fails to explain the observed results in solidified Argon and Neon. This indicates the existence of microscale fluctuations in the composition of the solid. In NaF the characteristic length has to be decreased by a factor of about five. For Diamond the value of the parameter A, which gives the best fit with the expriment, is hundred times the value calculated from Klemens expression for A. Good agreement with the experimental results beyond the conductivity maximum is obtained by taking (B_1+B_2) to be temperature independent.

64. Linear and Antilinear Transformations of the Dirac Wave Function for Massless Particles under Conformal Coordinate Transformations

N. C. Rastogi, Lucknow

Explicit expressions are given for the transformations of the wave function ψ when a relativistic conformal transformation of the coordinates is made. The possibility of antilinear transformations, which mix the original and the charge conjugate wave functions, is taken into account.

65. Electromagnetic Field of a Charged Particle in uniformly Accelerated Motion

Vachaspati and Sudarshan L. Punhani, Lucknow

A uniformly accelerated charge particle is peculiar in that it gives rise, at any given space-time point, *either* to a retarded *or* to an advanced electromagnetic field, but not to *both*. On general grounds one expects both kinds of fields to exist at all space-time points. The mathematical reason why only one kind of field exists in the case of uniform acceleration is pointed out and a limiting procedure is introduced to overcome the difficulty. It is then possible to obtain *both* kinds of fields at *all* points

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excepting the boundaries of some regions. The field at these boundaries can be determined by requiring that it should eliminate the presence of any unphysical charges. The solutions at these boundaries are not unique, contradicting a statement of Fulton and Rohrlich (1960) to this effect. Explicit expressions for the potentials and the fields are given. Our results partly confirm those of Bondi and Gold (1955).

66. Design of a Small Scale N-15 Column Assembly

D. Gupta*, M. N. Nayak*, Bombay

One of the most useful applications of the Squared off Cascade calculations lies in the determination of minimum column volumes for small scale production of stable isotopes based on the process of distillation, chemical exchange or exchange distillation. The minimum plant volume of an N-15 column assembly has been calculated based on the process of chemical exchange between NO and NHO_3 by using three different procedures developed in this laboratory. The design of the product refluxer has also been discussed briefly.

67. Various Approximation for the Isotopic Thermal Diffusion Factor. II. Application to Hydrogen Isotopes

S. C. Saxena and P. A. Pardeshi, Bombay

Numerical calculations are performed for the thermal diffusion factor of hydrogen isotopes in conjunction with the various theoretical formulae. New formulae are derived for the two limiting concentrations for the binary mixtures. These formulae are further simplified by expanding in terms of the reduced mass, and also as riatio of the two molecular masses. The accuracies of these approximate formulae are estimated by comparison against the rigorous formulae for several interesting binary mixtures of hydrogen isotopes. Approximate calculations are done to estimate the quantum corrections.

68. Multicomponent Diffusion in System Kr^{85}-He-Kr

B. N. Srivastava and R. Paul, Calcutta

The diffusion coefficients of Kr^{85} in trace quantities in mixtures of helium and normal krypton, as well as in pure helium and pure krypton, have been determined by using an all-metal apparatus. The apparatus consists of two diffusion chambers connected by a diffusion capillary of special design so that it can be opened or closed by a piston operated by a metal valve fitted with bellows. For analysis one of the chambers has a thin cellophene window with a scintillation counter placed close to it. First both the chambers were filled with the desired gas mixture and then a small amount of Kr^{85} was added to one chamber and the pressure equalised. Diffusion was then started and counting rate determined at regular intervals, from which the relaxation time and the diffusion coefficient were calculated. The diffusion coefficient

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$\mathscr{D}_{1\to 23}$ of Kr^{85} in the mixture of krypton and helium was found to be accurately given by the theoretically predicted formula

$$\frac{1}{\mathscr{D}_{1\to 23}} = \frac{C}{\mathscr{D}_{22}} + \frac{C_3}{\mathscr{D}_{23}}$$

where C_2, C_1 are the concentrations of normal krypton and helium and $\mathscr{D}_{23}$ the binary diffusion coefficient. As expected a plot of $1/\mathscr{D}_{1\to 23}$ against C_2 was found to be a straight line.

69. Knight Shifts in the Intermetallic Compound $PtSn_2$

S. S. Dharmatti, V. Udaya Shankar Rao and R. Vijayaraghavan
Bombay

Nuclear magnetic resonances of Pt^{195} and $Sn^{117,119}$ have been observed in the intermetallic compound $PtSn_2$. The Knight shift of Pt in $PtSn_2$ is negative and 0.16% in magnitude. Sn in $PtSn_2$ shows a positive Knight shift of 1.06%. Knight shift of Pt is interesting because in the pure metal it has a large negative Knight shift (−3.52%). The results are discussed from the point of view of exchange polarization of the inner *s*-shell electrons by the *d*-band electrons. Knight shifts in similar alloys will be reported.

70. Levels in Sb^{119}

R. K. Gupta, R. Srinavasa Raghavan, G. C. Pramila and S. R. Amtey
Bombay

The radiations from 5 day Te^{119m} (11/2-) and 16 hour Te^{119} ($\frac{1}{2}^+$) have been investigated by scintillation techniques on the expectation that both the low spin and high spin excited states of Sb^{119} will be populated in these decays. The gamma-rays of 153, 270, 930, 950, 1000, 1100, 1220 and 2100 kev from the decay of Te^{119m} and gamma-rays of 645 and 1760 kev from the decay Te^{119} have been detected. The summing and coincidence spectra show levels at 270, 645, 1220, 1370, 2290 and 2370 kev. A $g_{7/2}$ assignment for 270 kev level, expected from the systematics of $g_{7/2}$ levels in odd antimoney isotopes, agrees with experimental data.

71. Decay of Se^{75}

J. Varma and M. A. Eswaran, Bombay

The decay of 120 Se^{75} has been investigated employing NaI(Tl) scintillation spectrometer and coincidence technique. The intensities of the electron capture transitions to the 403,572 and 628 Kev states as of As^{75} are found to be in the ratio of $1 : 5.3\times10^{-4} : 2.4 : 10^{-4}$. On the basis of log ft values of the β- and electron capture transitions the orbitals of the 477, 572, 628 and 814 Kev states of As^{75} are estimated as 1/2-, 5/2-, 1/2- and 5/2 (or 7/2) respectively.

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72. Radiocarbon from Nuclear Reactors

P. Abraham and S. D. Soman, Bombay

Carbon-14 is one of the hazardous isotopes produced in nuclear reactors and by nuclear weapons tests. In nuclear reactors carbon-14 is produced by one of the following processes. (i) $N^{14}(n,p)\ C^{14}$, (ii) $O^{17}(n,\alpha)\ C^{14}$ and (iii) $C^{13}(n,\gamma)\ C^{14}$. The quantity of carbon-14 produced by these different reactions in Canada India Reactor at Trombay has been calculated. The radiocarbon in the gaseous effluent, at the point of release from CIR, is estimated to be only 1/25 of the maximum permissible concentration. The concentration of carbon-14 at ground level is insignificant.

The CIR, the total quantity of radiocarbon produced in the air, is 28.5 millicuries per day or 10.5 curies per year. In the primary cooling water, the rate of production of carbon-14 is 110 millicuries per year and in heavy water, the amount is 2.7 curies per year.

A relation is arrived at to estimate the amount of argon-41 produced in the effluent of any air-cooled reactor, knowing the quantity of carbon-14 produced.

73. Monitoring of Iodine-131 in Air using Activated Charcoal

S. K. Mehta and P. Kotrappa, Bombay

I-131 absorption efficiency of activated charcoal has been examined for the purpose of routine I-131 monitoring in air. A standard cartridge consisting of 14–22 mesh size charcoal in a $1\frac{1}{2}$ inch long glass tube of $\frac{1}{2}$ inch diameter has been designed for sampling I–131 from air. The standard cartridge picks up I–131 with an efficiency of 98 per cent and can be easily counted in a well-type scientillation counter. Air activity of 0.005 mpc can be detected in a 20 minute sample taken with 40 lit/min pump and higher activities in proportionately shorter time.

Some interesting observations on filter paper sampling are also reported herein.

74. Estimation of Tritium in Aqueous Samples

S. D. Soman, T. S. Iyengar, S. H. Sadarangani and P. K. Vaze, Bombay

The paper describes the construction, operation and standardization details of a gas phase counting system employed for the estimation of very soft beta emitters. The apparatus is being used for the estimation of tritium levels in the heavy water samples from various projects in Atomic Energy Establishment Trombay and urine samples of personnel working with tritium.

Hydrogen-tritium mixture is extracted from the test sample by reducing it with calcium at room temperature. This is dried and adapted for internal counting in a G. M. counter. The counter uses Burshane as quenching gas and has a plateau of 160 volts. The apparatus was standardised and the linearity in response over a wide range was established. Specific activity of tritium as low as 2×10^{-3} uc/ml could be estimated with the apparatus.

The paper also discusses the advantages of gas phase counting over other methods.

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75. Activation of Impurities in the Pool Water of the 'Apsara' Reactor

D. V. Gopinath, Bombay

The coolant water in reactors builds up radioactivity due to neutron irradiation of its constituents. An exact theoretical evaluation of such activity build-up involves parameters which are sometimes difficult to determine. In this paper is given a comparative study of the calculations of activity build-up made on simplified assumptions and the experimental values.

Water samples from the demineralising plant and the pool of the 'Apsara' reactor were irradiated for different times and at different power levels. The composite gamma-decay characteristics of these samples were calculated and compared with the experimental gamma-decay characteristics. It appears from this study that the radioactivity from any impurities not given in chemical analysis data or from the fast neutron reactions with coolant constituents is negligible after 15 minutes of cooling.

76. Temperature Build-up in Gamma Active Sphere

V. K. Sundaram, D. V. Gopinath and A. K. Ganguly, Bombay

One of the ultimate methods proposed for high level radioactive waste disposal is to contain the activity in ceramic bodies and bury them underground or in the deep sea. The limit of the activity that can be incorporated in such bodies is decided by the temperature rise in the body due to the absorption of nuclear radiation. The present paper discusses the temperature distribution in a solid sphere incorporating long lived gamma emitters and buried in a medium having the same thermal properties. Temperature build-up with time for MeV and steady state temperatures for 0.5, 1, 2 and 3 MeV gamma rays have been calculated at the centre and surface of a 20 cm radius sphere. The results are compared with the temperature distribution in a sphere containing long lived beta emitters. It is observed that the temperature rise due to the gamma emitters is about 75% of that due to a beta emitter of the same maximum energy.

77. Radiation Levels around CIR Primary Coolant System

T. N. Krishnamurthi, Bombay

In this paper is given a theoretical evaluation of the radioactivity build-up in the primary coolant water of Canada-India Reactor and the gamma field at different points on the surface and around the delay loop, located outside the reactor. The characteristics of the prominent impurities in the coolant water, their activity build-up under neutron irradiation, radiation dose due to these activities at different points of the loop, are presented in tables. These tables can be made use of for any easy computation of radiation levels near the delay pipe for different concentrations of the coolant water impurities.

78. Inelastic Scattering of Gamma Rays by Bound Electrons

J. Varma and M. A. Eswaran, Bombay

The inelastic scattering of the 662 Kev gamma rays from Cs^{137}, by the tightly bound *K*-shell electrons of lead has been studied employing sodium iodide counters

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and coincidence technique. After eleminating the interferring effects it is found that, unlike in the case of Compton effect, the scattered gamma rays have a broad energy distribution. The scattering cross-section is estimated to be much smaller than that reported by previous workers. The various effects which interfere with these measurements would be discussed.

79. Preparation of Eu^{156} and $Gd^{146,149}$ by Ion Exchange at room temperature

A. T. RANE, Bombay

Very high specific activity isotopes of Eu^{156} and $Gd^{146,149}$ were produced and purified from their targets by ion exchange separation using Dowex 50 resin (80–120) mesh size) and lactic acid as eluant, at room temperature, 28°C.

About 50 mgs. of enriched Sm^{154} (99%) were irradiated with high flux of neutrons in DIDO, Harwell. The Eu^{156} was formed thus :

$Sm^{154}(n,\gamma)$ $Sm \xrightarrow{155\beta}$ Eu^{155} (n, γ) Eu^{156}, $t_{\frac{1}{2}} = 15.4$d. Sm^{153} was simultaneously produced by reaction Sm^{152} (n,p) Sm^{153}, $t_{\frac{1}{2}} = 47$ h.

In another sample about 100 mgs. of ordinary europium were bombarded with 110 Mev proton beam. Gd^{146} and Gd^{149} were produced thus,

$Eu^{151}(p,6n)$ $Gd \xrightarrow{146Ec}$ Eu^{146} $t_{\frac{1}{2}} = 38$ h. and Eu^{151} $(p,3n)$ $Gd \xrightarrow[t_{\frac{1}{2}}=9.3d]{149Ec}$ Eu^{149}, $t_{\frac{1}{2}}=120$d.

Both $Gd^{146,149}$ and Eu were separated from their targets using ion exchange column of 18.5 cm in height and 1.6 cm in diameter. The *p*H of the lactic acid used was 3.45 in the case of $Gd^{146,149}$ and 3.53 in the case of Eu^{156}. The activities were examined by a scintillation counter and the elution curve showed a clean separation in the case of Gd–Eu and slight cross-contamination persisted in the case of Eu–Sm. The radiochemical purity was ascertained by examining the gamma ray spectrum of the separated fractions. The time required for both the separations was about 24 hours.

80. Low Energy Scattering of Electron by Variational Method

S. C. MUKHERJEE, Calcutta

In this paper the cross section of elastic scattering of electron by helium atom is calculated with allowance for exchange effect. The wave equation for this three body problem contains a term for the potential to which the incoming electron is subjected, the potential is evaluated by taking the ground state wave function of helium atom of the form of Taylor and Parr (1952). Then the phases are calculated from the differential equation obtained by the variational method of Hulthen (1944). When k, the electron wave number in atomic units, is 1.053, the value of the total scattering cross section becomes $3.39\pi a_0^2$, the exchange effect is neglected, this result compares favourably with that of Moiseiwitsch (1953) who obtains $4.18\ \pi a_0^2$ for the same with the simpler wave function of Hylleraas. If exchange effect is taken into consideration the cross section for this energy is found by Moiseiwitsch to be $3.25\ \pi a_0^2$.

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81. An investigation of the ^{7}Li (d,n) ^{8}Be Nuclear reaction using the Photographic Emulsion Technique

J. P. Sah, Lucknow

The energy levels of ^{8}Be have been studied by means of the ^{7}Li (d,n) ^{8}Be reaction using deuterons of energy 635 Kev. Photographic emulsions have been used as neutron detectors.

Evidence of levels in ^{8}Be was found at 2.9 and 10.4 Mev. The angular distribution of neutrons from this reaction has also been investigated.

The various modes of the reaction ^{7}Li$+d$ have been considered and the proportion of the total disintegrations corresponding to the formation of ^{8}Be in the ground or any of the excited states has been inferred.

82. On the Mass Determination of Σ-Hyperons and K-Meson

P. C. Mathur, Delhi

The mass of Σ^+ —hyperson has been determined using $\Sigma^+ \rightarrow P + \pi^0$ decays at rest in a well calibrated stack, exposed to a magnetically separated enriched K^- -meson beam from Bevatron. The stopping powers of the stack relative to standard emulsion is determined by measuring the μ-meson ranges from $\mu-\theta-e$ events. The thickness of each pellicle was measured before exposure and the shrinkage factor is therefore known to an accuracy of 1%. The masses of Σ–hyperson and K^- -meson are determined by the analysis of collinear events, resulting from interactions of K^-–mesons with the free Hydrogen nuclei. The following mass values are obtained :—

$$M_{\Sigma+} = (1189.8 \pm 0.5) \text{ Mev}$$

$$M_{\Sigma-} = (1196.8 \pm 0.8) \text{ Mev}$$

$$M_{K-} = (494.5 \pm 0.7) \text{ Mev}$$

$$M_{\Sigma-} - M_{\Sigma+} = (7.0 \pm 0.7) \text{ Mev}$$

The Σ^-, Σ^+ mass difference is independent of the accurate knowledge of the stopping power of the stack and is found by iteraction method. The mass value of the K–meson, obtained by this analysis, compares well with the mass value (492.8 ± 1.5) Mev obtained by the analysis of τ^--decay in flight in this stack.

The Σ-hyperons were produced by the capture of $K-$mesons in the emulsion nuclei.

83. Life-time and Asymmetries in Σ-Hyperson Decays

B. Bhowmik, G. R. Gupta, P. C. Jain, P. C. Mathur and N. T. Venkata Lakshmi, Delhi

The mean life-times of charged Σ-hypersons decaying via π^+ and π^- modes have been determined by maximum likelihood method. The charge of the hypersons have

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been determined by following the decay pions or the pions from the parent star. The following life-time estimates are obtained

$$\tau\,(\Sigma^{+}\pi^{+}) = (0.89\ {}^{+\infty}_{-0.50})\ 10^{-10}\ \text{sec.}$$

$$\tau\,(\Sigma^{-}\pi^{-}) = (1.35\ {}^{+9.75}_{-0.63})\ 10^{-10}\ \text{sec.}$$

considering the total sample, consisting of identified positive and negative hyperon decays as well as unidentified $\Sigma^{+}\pi^{+}$ decays we get

$$\tau\,(\Sigma^{+}\pi\pm) = (1.08\ {}^{+0.81}_{-0.33}) \times 10^{-10}\ \text{sec.}$$

a value intermediate between lifetime of Σ^{+} and Σ^{-} hypersons. The so called anomaly regarding life-time of the mixture of Σ^{+} decays which appeared to be even lower than the life-time of individual charged mode in earlier work is therefore unfounded. The effects of systematic and statistical errors on the determination of lifetime are discussed.

The lifetime of Σ^{+}-hyperson decaying via proton mode is determined by rest +fight method as well as by maximum likelihood method and is found to be in good agreement with each other. The values of lifetime obtained are

$$\tau\,(\Sigma_{p^{+}})_{F+R} = (0.98\ {}^{+0.42}_{-0.36}) \times 10^{-10}\ \text{sec.}$$

$$\tau\,(\Sigma_{p^{+}})_{F} = (0.96\ {}^{+1.46}_{-0.36}) \times 10^{-10}\ \text{sec.}$$

Up down asymmetries of the decay products of Σ-hypersons are determined with respect to the plane of production. No asymmetry is found within experimental errors.

The Σ-hypersons were produced by the capture of K-mesons in a G_5 emulsion stack exposed to an artificially produced enriched beam.

84. Concerning Fore-Aft Asymmetry in Λ°-Decay

B. Bhowmik, D. P. Goyal and N. K. Yamdgni, Delhi

A sample of Λ^{0}-hyperons identified by Q-value estimation has been used to study fore-aft asymmetry in the decay of the Λ^{0}-hyperon. From the consideration of the energy spectrum of Λ^{0}-hyperons the fraction produced by (a) strong interactions $K^{-}+N \rightarrow \Lambda^{0}+\pi$, $\Sigma+N \rightarrow \Lambda^{0}+N$; and (b) radiative decay $\Sigma^{0} \rightarrow \Lambda^{0}+\gamma$ have been separated. In the sample (a) the observed value of $\alpha \bar{P} = 0.23 \pm 0.24$ and $N_f/N_b = 25/27$, which is consistent with an isotropic distribution. For sample (b), the distribution is asymmetric and $\alpha \bar{P} = 1.12 \pm 0.27$ and $N_f/N_b = 33/9$. Thus Λ^{0}-hyperons produced by radiative decay display longitudinal polarisation, as expected. A scanning procedure has been adopted which eliminates any possible contribution of spurious fore-aft asymmetry due to scanning bias.

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85. Leptonic decay rates of hyperons

B. Bhowmik, Delhi

The first examples of leptonic decays of Σ and Δ^0-hypersons in nuclear emulsion have been observed in our experiment. Only one example of $\Sigma^- \rightarrow n + e^- + \bar{\nu}$ and two examples of $\Lambda^0 \rightarrow p + e^- + \bar{\nu}$ have been found. On the basis of these events our observed decay rate is consistent with the predicted rate according to Universal Fermi Interaction Theory. The rates obtained from bubble chamber data on the basis of $(2+n?)$ $\Sigma^- \beta$ decay and about 15 $\Lambda \beta^0$ decays are found to be an order of magnitude less than the predicted rate. The implication of these results are discussed.

Astrophysics

86. Internal Constitution of Cold Bodies

Y. Singh, Roorkee and V. K. Tewary, Delhi

The mass-radius relation and the density distribution of cold planetary bodies has been determined by incorporating Thomas Fermi Dirac equation of state into Kothari's theory of pressure ionization. The contributions of zero point energy of phonons, exchange interactions, and the correlation energy of the electrons have been explicity considered.

87. The Circularisation of Elliptical Orbit of a Small Bodies Revolving round their luminary

Shiva Kishore, Jullunder

Robertson and Poynting have shown that a small meteorite will be swept into the sun due to radiation from the sun. The author by taking the finite size of the meterorite had shown that it will start spinning, and Yarkovsky effect will also oprate and oppose Robertson Poynting effect and stabilise the orbit and it will not be swept into the sun.

In this paper the author has examined the combined effect of Yarkovsky effect and Robertson Poynting effect on an elliptical orbit and has shown that a force appears tending to circularise the orbit, its time contant being of the same order as that of pure Robertson Poynting effect, (i.e., in the absence of Yarkovsky effect.).

88. Condensation in C. Von Weizsacker vortex rings

Shiva Kishore, Jullunder

Weizsacker has postulated the evolution of planets from the small ball bearing vortexes between the main vortexes which form ring system, each ring having five vortexes. The ring being bigger and bigger in diameter with a factor of about two. The main vortexes being retrograde, the planet volution had to be postulated in the secondary ball bearing rings which have direct rotation. The assumption seems artificial to many scientists and hence is not universally accepted.

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The author has treated the main vortexes as bodies immune to rochie forces and has shown that they are non-rotating bodies and seem to rotate retrograde because of revolution. The interaction between the vorexes is shown to produce condensation and shrinking of vortexes as well as direct rotation. Due to inter-action of the vortexes of the same ring, direct spin acceleration will produc till the spin period equals revolution period. For interaction between vortexes of different rings the direct spin acceleration lasts till interaction lasts. The development of high spin results from the condensation and shrinkage with evolution. The merger of the nucleus of the vortexes of one ring in the ultimate phase is also shown to prouduce direct rotation. The condensation of matter from intermediate regions on the protoplanet is also shown to produce direct rotation. The condensation on extreme planets is shown to produce highly elliptical orbits.

89. The Dynamic Configuration of Bodies Immune to Rochie Force

Shiva Kishore, Jullunder

In this paper it has been shown that an elliptical body with axis ratio 1 : 2 moving in an orbit having its minor axis along the line joining the body to the centre but not spinning in space is composed of particles moving in independant orbital motion and without any mutual gravitation among the particles and hence such a body is immune to Rochie forces. Such a body has to change its shape by compression and expansion of its axis and hence it must not have rigidity and should be gaseous, liquid, or composed of minute dust particles.

It has therefore been concluded that a body can evolve out of matter having density lower than given by Rochie. However, it will have to conform to the condition given above for its being immune to Rochie forces.

In light of this it is not necessary to assume density above a certain minima for the evolution of our planets round the sun, even on the strength of purely gravitational forces and neglecting cohesion chemical and other binding forces.

90. The Energy-momentum Tensor for an Interesting Gravitational Field

R. V. Wagh, Bombay

There have been several attempts to investigate the gravitational field of Isolated rotating masses. Bass and Pirani, Thirring and others considered the case of rotating masses and shown the resulting gravitational field, which leaves the pressure isotropic. It has been shown in the earlier note that the pressure remains isotropic to a first degree of approximation. It is established here that in the case of rotating masses introduced in a Galilean field the condition of isotropy is not satisfied in general.

The line element for this case has been taken as

$$ds^2 = -dr^2 - r^2 d\theta^2 - r^2 \sin^2\theta d\phi^2 + dt^2$$

along with, $v^1 = \frac{dr}{ds} = 0, \qquad v^2 = \frac{d\theta}{ds} = 0,$

$$v^3 = \frac{d\phi}{ds} \neq 0, \qquad v^4 = \frac{dt}{ds} \neq 0$$

$\frac{v^3}{v^4} = \Omega$ which is of the nature of an angular velocity. The solution in this case is found, giving $T_1^1 = T_2^2 = T_3^3 \neq 0$.

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At $R = 0$, which is the centre of the system of rotating masses, the energy is found to be equal to Zero at the Time T.

91. Decay of Shock Waves in Stellar Atmosphere

M. S. Bhatnagar and R. S. Kushwaha, Delhi

The Brinkley-Kirkwood (1947) theory of propagation of shock waves is further developed for application to Astrophysics. So far it has not been possible mathemeticially to taken into account the energy lost by radiation(which escapes into inter-stellar space). An estimate of this energy loss is made in the present note on the assumption that the gas first loses energy due to radiation behind the shock front at constant volume and then expands adiabatically to its original pressure. The radial velocity computed on this assumption for the β-Cephei star BW Vulpeculae is found to be in good agreement with the observations and also the time of decay of the shock wave is of the order of the observed time of variations of radial velocity.

92. Random Fragmentation in Star Formation in Globular Clusters

M. M. Gupta and R. S. Kushwaha, Delhi

The theory of random fragmentation is applied to the star formation in M 92 and M 3. It is assumed that the prestellar configuration has a homogenous density distribution of material. The fragmentation took place as a single event and the various stars have different rates of evolution depending upon the mass. Consequently at the present time they are found in various stages of evolution. From comparison of the theoretical mass distribution curve for fragments and the observed mass frequency curve of stars an estimate of the masses of the two presteller cloud oconfigurations have been made. These masses are found of the same order as those obtained from dynamical considerations.

93. Equilibrium Abundances of Stable Isotopes

Hira Lal Duorah, Delhi

Equilibrium distribution calculated on the basis of the analogue of Saha's ionization formula is examined with the recent nuclear masses and abundance data. It is found that up to $A = 92$, the abundance distribution can be well reproduced. The electron degeneracy which becomes important has also been considered for the region $A = 64$–92. The equilibrium temperature is found to be 6.5×10 degrees. The neutrality condition is taken to have been satisfied by protons, neutrons, electrons and alpha-particles. The presence of position is not considered. Through effects of the excited levels are neglected the differences between the even and odd nuclei are taken into account.

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94. Convection Zones in Stellar Atmospheres

K. S. Krishna Swamy and R. S. Kushwaha, Delhi

In the following the evolution of stars to the cooler regions of giants in H–R diagram one has to fit up core solutions with the atmospheric solutions. For this essential parameter is the constant that joins the pressure and temperature at the end of ionisation zone. The distribution of this parameter in the H–R diagram has been studied by computing atmospheric models. The value of the constant of the adiabatic relation is found to be less for giants than for main sequence stars for the same spectral type. In the case of the sun, it is found that the convection zone extends to about 30% of the solar radius which is within the limits of the values obtained by other workers.

Instruments.

95. Preparation of Arbitrary Scales for Controlled Movements

V. Venkateswara Rao, Warangal

In some of the physical instruments, controlled movements with reproducibility of the settings are more essential than absolute measurements. In the case of large grating spectrographs, particularly mounted in the manner suggested by Eagle, controlled movements and precise resettings are necessary for the translation along the rails and rotation about the vertical axis of the grating carriage and the tilt of the plate holder on the sector.

For the arbitary scale attached to the vertical axis, the micrometer arrangement is prepared first. The micrometer screw of $\frac{1}{2}$ mm. pitch carries a head (divided into 50 equal parts) which moves across a scale with $\frac{1}{2}$ mm. divisions. The circular scale is graduated with reference to the travel of the micrometer screw such that each division on it, corresponds to 10 divisions of the screw scale. Any position of the grating about the vertical axis can be defined by the scales on the disc, the micrometer screw and the head.

Usually a worm and wormgear arrangement is incorporated for such rotations, but the gear assembly inevitably introduces back-lash and its consequent errors from which the present arrangement is free. The scale is sufficiently fine and it is possible to rotate the grating through 1/500 of a division on the disc directly and by 1/5000 of a division by estimation, which is, in practice, found to be sufficient for giving reproducible settings to the grating.

This principle can be adopted wherever an arbitrary circular scale is required.

96. A Linear Radio Frequency Field Intensity Meter

Dr. V. G. Kher and V. L. Lokre, Nagpur

The conventional signal strength meters have generally non-linear scale which is crowded at both the ends. Even the more complicated and costly commercial instruments employing electronically regulated power supply develop a tendency towards a zero drift after some use. For accurate study of radio signal intensities, a simple,

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linear and stable signal strength meter is constructed with components that are readily available in any laboratory. This instrument employs a modified cathode follower circuit. Overlapping ranges are provided in this meter enabling comparison of radings taken on successive ranges. The calibration curves are linear in the range of variation usually met with. For visual observations a suitable damped linear micro-ammeter of range 0–60 with 60 divisions on the dial in used as an indicator. For continuous photographic recording multiflex or any other similar galvanometer is used. This instrument measures radio frequency voltages from 5 micro volts to more than 1.5 volts. The accuracy of measurement of varying radio fields is less than 15% for visual observations and for recorded observations it is less than 10 per cent. This circuit can be easily modified for actuating a pen and ink recorded of any range. Such modification has also been carried out. This instrument can also be used as an R.F. micro volt meter.

97. The Proposed Logic for an Analog Data Sampling System

S. K. Basu and R. R. Nargundkar, Bombay

A logical set up is described for direct feeding of digitized analog data to a digital computer. The sampled data is loaded to a buffer register when it is ready, and then serially shifted into the machine by the sequencing unit. The machine interrogates the digitizer by a special order code. The sequence however, does not go further till the operation complete pulse from the digitizer comes. A stored subroutine interrogates the buffer register three times per cycle. Each time 4 bits of binary coded decimal data are ready into the Multiplier Quotient register and processed. During this reading in period, the buffer register is isolated from the digitizer which proceeds with the next set of data.

98. A Gray Code Generator

M. V. Pitke and S. V. Rangaswamy, Bombay

This paper first describes a straight forward method of generating an n-bit Gray Code (reflected-binary code) employing at least 'n' Flip-Flope and '2^n' n-input AND gates. A simplied method for generating the Gray Code which results in high circuit economy is given later. This n-bit Gray Code counter consists of 'n' scale-of-two counters and an equal number of modulo two adders.

99. Optimum Counting Time and Resolving Time Calculator

S. P. S. Khalsa and L. H. Peshori, Bombay

The paper describes the development of a calculator which is intended to ease the calculation of optimum counting time (or optimum number of counts) of the background and the background plus sample counting for a specified percentage standard statistical error in assay of radio active samples.

Graphs are drawn for the specified case when the background is considered relatively constant (i.e., when the counter is well shielded) and it is not necessary to repeat

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the background reading for each sample, background being taken only once with a considerably high accuracy. The graphs give the number of counts required for a predetermined accuracy when sample plus background and background ratio is approximately known.

The use of the calculator for the comparison of counters in respect of their total optimum counting time for a known background and sample counting rate, is given.

Calculation of different types of counting errors such as probable, standard, nine-tenth, etc. may be also be made with the help of the calculator.

Provision is made to account for the counting losses due to the resolving time of detector or probe unit.

100. A New Design for Dekatron Drive

P. K. PATWARDHAN, Bombay

Dekatrons are finding increasing applications as counting devices, because of the simplicity of their operation, low cost and economy in terms of components and space requirements. Dekatrons are used as Display Elements in Multi-Channel Pulse Height Analysers. Such a design is economical and quite stable. A 100 Channel design incorporating, fast, GC10D dekatron display and with Dead Time comparable to Magnetic Core Storage type analysers has been described else where. Each channel store consists of the first dekatron operated on a Two Pulse Mode with 'gating'; followed by another dekatron driven by a new circuit, which is being described in this paper. The new design results in cutting down the capital and running cost, considering that only 9 components are required for the new circuit as against 16 required for the conventional drive. Two different Plug-in-unit designs for channel storage are discussed in this paper.

101. Further Studies on the Operational Characteristics of a Burshane Gas Flow Counter

C. H. PAREKH, Bombay

A gas flow counter making use of the commercial fuel 'Burshane' has been designed by the Electronics Division, Atomic Energy Establishment Trombay. The design and performance of this counter were described by the author in a paper presented to the forty eighth session of the Indian Science Congress at Roorkee. In the present paper the results of further studies on the operational characteristics of the counter are described. The threshold voltage for counting was found to reduce as the sourceanode distance was decreased. Studies of the effect of the anode loop diameter on the threshold voltage indicated an optimum loop size of 1.8 cm corresponding to a loop radius of 0.75 cm. A systematic analytical investigation of the phenomenon revealed that the optimum loop radius would be 0.94 cm. By constructing a counter which approached closer to the model used in the analytical study, a value of 0.89 cm was obtained in much better agreement with the calculated value. A flow counter making use of a disc anode gave no indication of any optimum size.

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102. Analysis of Vibrations using a pair of Coarse Transmission Gratings

Gopala Menon Sreekantath and Karunakaran Nair K,
Trivandrum

Au optical device consisting of a pair of exactly similar coarse transmission gratings having opaque and transparent elements of the same width $\Delta/2$, a collimator and a telescope with a photo-electric cell substituted in the place of the eye-piece, has been developed for the analysis of vibrations sustained or transient.

The gratings are held one behind the other at a distance, a small odd multiple of Δ^2/λ, where λ is the wavelength of the light illuminating the slit and the twice diffracted zero-order image of the slit narrowed to such a width that either a dark or bright interference band covers it completely, is formed on the photo-electric cell. The vibrations to be analysed are transmitted to one of the gratings so that it moves laterally relative to the other with a velocity V at any given instance, when electrical pulses of frequency and intensity proportional to V are generated. These pulses after amplification are recorded on a magnetic tape and the tape record is used leisurely to find out the frequency of the pulses at any instant. The device is particularly useful in determining the velocity of a shockwave as it advances.

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SECTION OF CHEMISTRY

President :—PROF. R. P. MITRA, D.Sc., F.N.I.

Abstracts.

ANALYTICAL

1. Colorimetric estimation of cobalt as the thiocyanate complex—Part II. Use of tri-n-butyl phosphate as extractant for the complex.

M. R. VERMA and P. K. GUPTA, New Delhi.

The cobalt-thiocyanate or the—thiocyanate-2-picoline or acetone complex can be extracted from the aqueous solution by tri-n-butyl phosphate. The latter is uniformly blue in colour and has an absorption peak at 620 mμ. The solution obeys Beer's law and the optical density measurements can be made a basis for the estimation of cobalt over a fairly wide range of concentrations.

2. Colorimetric estimation of cobalt as the thiocyanate complex—Part I. Use of 2-picoline as the complexing agent in aqueous solutions.

M. R. VERMA and P. K. GUPTA, New Delhi.

A new system cobalt-thiocyanate—2-picoline has been investigated and it has been shown that at pH 9, the solution has a maximum absorption at 322 mμ. There is another peak at 620 mμ in the visible region of the absorption spectrum of the above system.

Optical density in the visible region obeys Beer's law and the solution is very stable. This can be made the basis of a colorimetric determination of cobalt.

3. Paper Chromatography of Fe++ and Fe+++.

MOHSIN QURESHY and MISS IQBAL AKTAR, Aligarh.

Paper Chromatography of Fe++ and Fe+++ has been studied. HCl (4 M) : N-Butanol : Acetic acid : Acetone (1 : 1 : 1 : 1) gives the best results. The separation is good at pH values ranging from (2·25—3·95). The presence of Al+++ did not affect the separation significantly.

4. Spectrophotometric determination of metal ion concentration in Heavy metal Soaps.

RIZWANUL HAQUE and WAHID U. MALIK, Aligarh.

Solution of nickel, cobalt and copper soaps of myristic and palmitic acids in pyridine exhibit maxima at 650 mμ, 450 mμ and 675 mμ respectively. Working at these wave lengths it had been found possible to use spectro-photometric method for the estimation of small amount of the metals in the respective soaps.

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5. Influence of acids and salts on the use of Mn(iii) as an oxidising titrant.

MOHD. AJMAL and WAHID U. Malik, Aligarh.

Manganic sulphate solution has been found to be a suitable oxidising titrant for the estimation of lower valence ions like Iron (ii) and Tin (ii), separately as well as in their mixtures. These results indicate that the presence of the hydrogen ions and anions (chloride in the case of $SnCl_2$ and sulphate in the case of Iron (ii)) appreciably increase the values of $\frac{\Delta E}{\Delta V}$ at the inflexion point. In the mixture of these two ions the inflexion for the stannous-stannic equilibrium was found to be much smaller than the ferrous-ferric equilibrium. The bright platinum electrode was found to give better results than the mercury electrode.

6. Determination of basicity of chrome liquors containing organic acids.

D. RAMASWAMY, MISS S. C. SUMATHI and Y. NAYUDAMMA, Madras.

Determination of basicity of chrome liquor by both Procter and Lehigh methods is subject to error when organic acids are present. Low basicity values and in some cases even negative values have been reported for sugar reduced liquor and other types of chrome liquors containing large amounts of organic acids. In the method that has been suggested, the organic acids together with any strong mineral acid are first removed by solvent extraction technique by extracting with tertiary amyl alcohol-n-butanol mixture. The basicity of the chrome liquor was then found out by Lehigh method. The method has been applied to some commercial chrome liquors and other prepared liquors and uniformly higher basicity values have been obtained.

7. "Volumetric estimation of iron in presence of Hydrochloric acid by Potassium Permanganate".

TARA CHANDRA GUPTA and ABANI K. BHATTACHARYA, Agra.

Ferrous ammonium sulphate has been volumetrically estimated against a standard solution of postassium permanganate in the presence of hydrochloric acid. The limiting concentration of hydrochloric acid permissible for the titration without affecting the accuracy of the results within ±0·5% has been determined. The estimations have been done in hydrochloric acid system by adding manganous sulphate, phosphoric acid and Reinhardt-Zimmermann reagent (Sulphuric acid, phosphoric acid and manganous sulphate), which is known to be the most effective preventive solution. The relative merit of manganous sulphate, phosphoric acid and their combination in the Reinhardt-Zimmermann reagent has been discussed.

8. Spectrophotometric determination of beryllium with 2-(3-carboxy-2-pyridylazo)-chromotropic acid (tri-sodium salt).

A. K. MAJUMDAR and A. B. CHATTERJEE, Calcutta.

Trisodium salt of (3-carboxy-2-pyridylazo-) chromotropic acid has been used for the colorimetric determination of micro-amounts of beryllium. The red-violet complex shows maximum absorption at 590 mμ and obeys Beer's law from 0·1 to ·2·0 p.p.m. of beryllium. However, the optimum concentration range has been found to be from 0·2 to 2 p.p.m. of beryllium, where the per cent relative error per 1%

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absolute photometric error is 3·028. The sensitivity of the reaction per cm^2 is 0·0048γ Be. The composition of the complex in solution as determined by Job's method suggests a metal to reagent ratio of 3 :2 and its instability constant is as $9·546 \times 10^{-6}$.

9. A Colorimetric method for the determination of procaine in solution in micro-quantities.

R. N. BHATTACHARYA, Calcutta.

During a study on the stability of procaine hydrochloride in solution a suitable method was developed for its determination in micro-quantities. The method consists of diazotisation of procaine with sodium nitrite and hydrochloric acid, removal of excess nitrous acid by reaction with urea, and coupling the diazotised compound with n-naphthyl-ethylene diamine hydrochloride.

The pink colour obtained was found to have maximum absorption at 545 mμ and was found to obey Beer's law between 1 μg and 6 μg. The $E^{1\ per\ cent}_{1\ cm.}$ value for the dye calculated in terms of procaine base was found to be 1608.

The colour formation can be used for identification of procaine on paper after paper electrophoresis in quantities up to 0·1 μg.

Conditions necessary for the best formation of colour, for its use in quantitative analysis and its stability have been given.

10. Separation of Aluminium from Iron by Ion-exchange.

A. N. CHOWDHURY and S. BANERJEE, Calcutta.

Al^{+3} forms a comparatively weak complex with versene EDG (Ethanolamine-diacetic acid) whereas Fe^{+3} EDG complex is a fairly stable one and anionic complex. The separation of Al^{+3} from Fe^{+3} can be carried out on a Dowex 50 column by passing the solution containing EDG adjusted to pH 2·5 to 4. The Dowex 50 should be in the ammonium form and conditioned to the pH of the solution by passing a 1% ammonium acetate solution adjusted to the pH of the solution with dil.HCl before the actual separation procedure.

The solution containing Fe^{+3} and Al^{+3} is treated with versene EDG and then adjusted to the proper pH and passed through the ion exchange resin column. Al^{+3} is retained in the ion-exchange column but Fe^{+3} passes in the effluent. The column is then washed with 1% EDG solution adjusted to pH 3·0 to remove any traces of iron exchanged in the column. Al retained in the ion exchange column is then washed out with 4N HCl and determined either as oxinate or by other conventional procedure.

Iron to aluminium ratio has been studied ranging from 0·5 to 50 and this procedure gives a clean separation.

Be^{+3} and UO_2^{+3} interfere as they are retained by the ion-exchange column under the same conditions. Interference due to Ti^{+2} can be avoided by adding H_2O_2 when titanium passes in the effluent.

11. A note on detection and identification of isomeric xylenols in the presence of one another.

M. R. VERMA, P. K. GUPTA and K. C. GROVER, New Delhi.

Spots of 2 :6-xylenol and 3 :6-xylenol and mixture of these were applied separately on the base line of filter paper coupled with diazotised Amino J-Acid and

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the spots developed with aqueous layer of 2% sodium carbonate iso-amyl alcohol solutions. The spots due to isomeric xylenols had Rf values reasonably apart and were different in colour. These could be resolved from a mixture.

12. Bis- Salicylaldehyde-ethylenediamine as an analytical Reagent—Estimation of Nickel.

B. R. SINGH and SATYA KUMAR, Nainital.

Nickel is quantitatively precipitated using Bis-Salicylaldehyde-ethylenediamine reagent in the pH range of 10·5—13·5. The complex is quite stable in ammonia, N caustic alkali and complexing agents as tartrate, citrate, iodide, fluoride, thiosulphate, thiourea, and triethanolamine. Using tartrate and ammonia, those ions which do not react with the reagent, are kept in solution. As^{+3}, Sb^{+3}, Sn^{+2}, Bi^{+3}, and Zn^{+2} remain in solution at a high pH, using tartrate and 0·1 N caustic alkali. As^{+3}, Sb^{+3}, and Sn^{+2} are also separated using fluoride as the masking agent. Fe^{+3} is separated by using triethanolamine as the complexing agent at a pH of 13·0. Hg^{+2} forms a soluble iodide complex and is thus separated from nickel. Cobalt upto 50 mg. can be separated from nickel (20 mg.) by converting to a stable cobaltamine by an excess of ammonia.

13. Estimation of copper and nickel by res-n-butyro-phenone oxime.

J. S. DAVE and A. R. PATEL, Baroda.

In continuation of our work on the analytical applications of the substituted ketoximes of resacetophenone (Curr. Science, *29*, 472 (1960); J. Sc. Ind. Res., *20B*, 81, 1961), we here present some of the investigations on the use of res-n-butyrophenone oxime as an analytical reagent for copper and nickel. It is observed that copper and nickel can be estimated quantitatively by this reagent to the accuracy of ± 0·3% and ± 0·5% respectively. Further work is in progress.

14. Separation of Silver from lead and mercury (I) by cation exchange chromatography.

S. M. KHOPKAR and A. K. DE, Calcutta.

Cation exchange chromatographic separation of silver from lead and mercury (I) was accomplished by making use of organic solvent eluents on Dowex 50W-X8 in the hydrogen form. The various eluting agents used consisted of the mixtures of acetone+nitric acid; acetone+ammonium acetate; acetone+ethylacetate+ammonium acetate; butanol+ammonium acetate; and butanol+ammonium acetate+acetic acid. The separation of silver from lead and mercury(I) by 250 ml. of butanol+ammonium acetate (1M) proved successful as lead was selectively eluted with (150 ml.) of this eluent; mercury (I) with next (100 ml.) portion of same eluent, whereas silver remained strongly adsorbed in reduced state on the resin. It was quantitatively eluted later on with 200 ml. of 4M nitric acid.

15. Extraction and Simultaneous Spectrophotometric Determination of Cobalt (II) with 2-Thenoyltrifluoroacetone.

S. K. MAJUMDAR and A. K. DE, Calcutta.

A method for the rapid extraction and the simultaneous spectrophotometric determination of cobalt (II) at milligram levels has been developed by utilising

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2-thenoyltrifluoroacetone (TTA) in acetone. The bright yellow cobalt (II)-TTA chelate in acetone (benzene) adheres to Beer's law at 430 mμ over the concentration range of 12—51 γ of cobalt (II) per ml. Around pH 5·1—6·8, cobalt (II) is quantitatively extracted from the aqueous phase by 0·15M TTA-acetone. The colour of complex is stable up to 96 hours. The system can tolerate as much as (0·5—10 mg.) each of silver, lead (II), mercury (II), thorium (IV), zirconium (IV), zinc (II) and strontium (II). The method is reproducible to within ±1·5%.

16. New reagent for titanium.

S. D. PAUL and M. S. KRISHNAN, Bombay.

2, 4, 6-trihydroxy phenylbenzyl ketone has been found to give yellow colour with titanium. This reaction has been used for the detection of titanium by spot test. The test is very sensitive and up to 0·05γ of titanium can be detected. The reagent can also be used for the detection of titanium in steel. Interference and mechanism of the reaction are also discussed.

17. Separation of Uranium and Thorium with Octylpyrophosphoric acid (OPPA) in a Phosphate medium.

R. S. JANI, Bombay.

The solvent extraction of uranium from phosphate rocks using octylpyrophosphoric acid reported earlier has been extended for the separation of uranium (VI) and thorium. The method is effective, both in phosphate and sulphate medii and has an advantage over using TBP in these respects. With 10% solution of octylpyrophosphoric acid in kerosene the extraction values of 96% for uranium and 91 per cent for thorium were obtained.

18. A Rapid Turbidimetric Assay Method of Chloramphenicol.

R. B. MUKHERJEE, J. CHATTERJEE, B. K. BOSE and B. N. DUTTA, Calcutta.

The microbiological assay of chloramphenicol is usually carried out by the diffusion plate assay that is, cup plate method employing *Sarcina lutea* or *Bacillus subtilus* as test organisms; the former method has been adopted as the recommended method of the U.S.P. XVI 1960. Assay by the measurement of antimicrobial activity may be accomplished by turbidimetric, i.e., the 50% inhibition of *Shigella sonnei,* but due to pathogenic character of this organism the method has not been accepted as a routine procedure. Due to inherent advantages of the turbidimetric (tube) assay procedure as being more sensitive than the plate method and very rapid requiring only 3-4 hours instead of about 16-18 hours in case of cup plate technique, this method has been employed in the assay of chloramphenicol using different fast growing organisms such as *Micrococcus pyogenes var aureus 6538 P, Escherichia coli* mutant (3 strains), *Klebsiela pneumoniae ATCC 10031, Salmonella typhosa* (3 strains), *Salmonella paratyphosa B, Shigella paradysenterica, Shigella sonnei.* Chloramphenicol and other antibiotics can be assayed microbiologically employing *L. arabenosus 17-5* and *L. casei ATCC 7469* grown in enriched media employed for the vitamin assay instead of nutrient broth. Standard conditions of assay viz., dose of inoculum, time of incubation etc., were worked out with each of the microorganisms and reproducible results were obtained with errors permis-

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sible under biological assay. The concentration of the drug to produce 50% inhibition of the maximum growth and the minimum effective dose of the drug were determined in case of all these organisms. It has been found that any of the strains can be employed for the microbiological determination of chloramphenicol. Of all the strains of assay organisms studied, *E. coli* (any standard strain), *Micrococcus pyogenes var aureus ATCC 6538 P* and *Lactobacillus arabinosus 17-5* may be recommended for the routine turbidimetric assay of chloramphenicol. This same technique has been found successful for the turbidimetric assay of penicillin and tetracycline. The assay values obtained by this procedure were found to agree fairly well with those obtained by the simultaneous determination of chloramphenicol by the cup plate method employing *Sarcina lutea* and the ultraviolet spectrophotometric method. The advantages of this turbidimetric method over the cup plate technique and the possible applications of the method in the assay of mixtures of antibiotics and rapid determination of bacterial sensitivity tests of recently evolved antibiotic resistant strains have been discussed.

19. Estimation of Polyvinylpyrrolidone in Plasma Substitute Preparations.

KANTI BASU and B. N. DUTTA, Calcutta.

Polyvinylpyrrolidone (PVP) developed during the last great war in Germany is being widely employed as a plasma substitute in the treatment of different conditions of shock, circulatory failure and fluid loss. Three different methods of assay have been developed by us and compared with the standard kjeldahl technique of estimation of nitrogen.

The ultraviolet spectra of the PVP solution at pH 1, 5 and 12 were studied using Hilger Uvispeck Spectrophotometer. PVP was found to exhibit peak at 212 mμ at pH 1 and 5 at 215 mμ at pH 12. The spectrophotometric method consists of diluting the PVP solution to the concentration of drug to about 70—80 mcg/ml, adjusting the pH to 5 (approx.) and reading the absorbance of the solution at 212 mμ. The turbidimetric method consists of adding trichloracetic acid to the PVP solution in presence of gum acacia solution and reading the turbidity produced at 660 mμ in a Klett Summerson photoelectric colorimeter. This method obeys the Beer's Law for concentration of PVP 200 to 1000 mcg per ml. of the final reaction mixture. PVP was found to produce a red colour by reacting with p-dimethylamino benzaldehyde in presence of sulphuric acid, which exhibits a typical spectra at 205 mμ, 235 mμ, 303 mμ and 351 mμ in the ultraviolet region and at 520 mμ in the visible region. This reaction has been developed into a colorimetric method of assay of PVP, which consists of reading a solution containing PVP about 30—40 mcg/ml. at 352 mμ or at 520 mμ. The kjeldahl method followed by us consists of digesting the sample containing about 350 mg. with concentrated sulphuric acid in presence of anhydrous sodium sulphate, and selenium and distilling off the ammonia in 4% boric acid solution and titrated with N/10 H_2SO_4 using methyl red as indicator. A comparative study shows that all these methods gave about the same average value of PVP in plasma substitute preparations. The spectrophotometric assay method appears to be the most accurate and should be the method of choice. The colorimetric method with dimethylaminobenzaldehyde is difficult to manipulate for reproducible results and cannot be recommended as a routine procedure. On the other hand, the turbidimetric method has been found to be rapid and accurate and can be adopted in a laboratory for the routine analysis of PVP. The kjeldahl method of estimation of nitrogen requires about a minimum of 4 to 5 hours but by using the spectrophotometric or turbidimetric method the analysis can be completed within a period of 15-20 minutes.

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20. A Rapid Colorimetric Assay Method of Tetracycline, Oxytetracycline and Chlortetracycline.

K. C. AGRAWAL and B. N. DUTTA, Calcutta.

A new colour reaction of tetracycline, oxytetracycline and chlortetracycline has been investigated. It was found by us that the yellow colour given by tetracycline, and chlortetracycline on heating with hydrochloric acid is much intensified by the addition of alcoholic sodium nitrite solution and acetic acid. Under similar conditions of treatment oxytetracycline does not give any colour with hydrochloric acid but produces a yellow colour on treatment with alcoholic sodium nitrite solution and acetic acid. The colours formed by tetracycline, oxytetracycline and chlortetracycline were found to exhibit maximum peaks at 450 mμ, 430 mμ and 480 mμ respectively and are found to be stable for 5—10 minutes. Different conditions for maximum colour development viz., time, temperature, concentration, hydrochloric acid, acetic acid and solvent were studied and the colour produced are read at their appropriate wavelengths in a spectrophotometer or Klett Summerson photoelectric colorimeter for the colorimetric determination of the tetracycline group of antibiotics. It was further observed that this colour reaction is not shared by any of the antibiotics—penicillin G (sodium or potassium), streptomycin or dihydrostreptomycin or chloramphenicol. Thus, this method can be employed for the determination of tetracycline or its derivatives in mixtures with the other antibiotics. This method is rapid and the analysis can be completed easily within 25 minutes. Moreover, this method has the special advantage over the U.S.P. control assay method where the taking of the readings exactly after six minutes after addition of alkali is difficult from practical standpoint of view.

21. Estimation of Strychnine in Pharmaceutical Preparations.

KANTI BASU and B. N. DUTTA, Calcutta.

The method of estimation of strychnine in pharmaceutical mixtures containing quinine, emetine, or atropine, iron and manganese salts and glycerophosphates is very difficult, laborious and time-consuming and the literature on the subject is relatively sparse. New colour reactions of strychnine have been studied for its quantitative determination. The first method is based on the formation of a yellow nitro compound with strychnine by treatment with nitric acid (1 : 1) and phosphoric acid which becomes intensified to a golden yellow colour by treatment with sodium hydroxide solution. The spectra of the compounds of strychnine formed in both acid and alkaline solution were studitd in a Hilger Uvispeck Spectrophotometer. In nitric acid solution the yellow colour exhibits absorption peaks at 235 mμ, 303 mμ and 365 mμ while the golden colour in the alkaline solution exhibits peaks at 231 mμ, 304 mμ, 375 mμ and 425 mμ. The assay procedure consists of measuring the golden yellow colour at 425 mμ in a suitable spectrophotometer or Klett Summerson photoelectric colorimeter using Filter 42. Different procedures for estimation of strychnine in pharmaceutical formulations in presence of quinine and iron and other metallic salts have been worked out. This method is not applicable to the estimation of strychnine in presence of atropine or emetine. The second method is relatively more sensitive and is based on the development of an intense red colour with ceric ammonium sulphate in presence of sulphuric acid and acetic acid. The spectra of the red colour in the visible range shows maximum peak at 505 mμ and the assay procedure consists of measuring absorbance of the coloured solution at 505 mμ within 10 minutes of its development. This reaction is not shared by quinine, atropine or emetine and therefore, can be employed for the determination of strychnine in their presence in different pharma-

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ceutical mixtures. Recovery experiments show that both the methods are rapid, quantitative and can be recommended for the determination of strychnine in different types of pharmaceutical mixtures.

22. A new method for Direct Spectrophotometric Determination of Aluminium with SPADNS.

GURUPADA BANERJEE and A. N. CHOWDHURY, Calcutta.

A new spectrophotometric method has been developed for the direct determination of microgram amounts of aluminium using SPADNS as the colour-forming reagent. It is based on the fact that aluminium forms a blue-violet lake with SPADNS.

The procedure developed for the micro-determination of aluminium in the range from 1·0 to 15γ in 25 ml. of final volume involves the adjustment of pH (4-5), addition of 2 ml. 0·1% organic reagent and 2 ml. 1% freshly prepared starch solution as stabilizer, dilution to volume and measurement of optical density after definite interval of time in a Unicam SP600 spectrophotometer versus a reference solution of the reagent. Spectral transmittancy curve for the reagent blank and 100γ Al has been prepared and the optimum wavelength has been chosen as 590 mμ where the absorption of the reagent is very small. It has been observed that 2 ml. of a solution of 0·1% SPADNS is sufficient to complex at least 0·1 mg. of aluminium. Between a pH of 4·0 and 5·0, the absorption of Al-SPADNS lake remains constant and above pH 5·0, the absorption decreases rapidly. The coloured system obeys Beer's law in the range 1—15γ Al. The spectrophotometric sensitivity of the Al-SPADNS colour system is 0·05 γ Al per Cm^2. The empirical formula of the coloured complex has been determined by the slope Ratio method which suggests a 1 : 1 complex for aluminium with the reagent.

The method finds application in the direct determination of alumina in iron ore.

23. A rapid method for the determination of Sulphur in Coal.

M. M. ROY and A. N. CHOWDHURY, Calcutta.

A rapid method for the determination of total Sulphur in Coal and Coke, using vanadium pentoxide and platinised asbestos as the catalyst, has been developed. The whole experiment is completed within 20 to 25 minutes. In this method, the samples are mixed thoroughly with varying percentages of the catalysts and heated in a furnace at a temperoture of 800°—850°C in presence of oxygen and the issuing gases absorbed in Hydrogen peroxide. The resulting sulphuric acid was estimated by (1) Barium Sulphate precipitation method and (2) Direct Titration. The results show that the optimum concentration of platinised asbestos used should be 3% on the weight of sample taken, the maximum deviation being 0·04—0·45% in the case of low-sulphur coal or cokes, and 0·5 to 0·6% in case of high sulphur ones, as compared to the classical Eschka method. With 100% vanadium pentoxide as added substance, the results agree within less than 0·5%. Further works on the effects of mixture of varying percentages of platinised asbestos and vanadium pentoxide as also the effects of other catalysts are in progress.

24. Rapid Colorimetric Determination of Fluorides in Presence of Aluminium.

T. S. BHAKUNI and N. N. SHARMA, Nagpur.

Aluminium has been known to interfere with the estimation of fluorides in waters. Megregian (1954) used Zirconium Erio-chrome Cyanine-R lake for the

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estimation of fluorides. The effect of aluminium by this method was reduced to minimum provided two hours reaction time was allowed. Megregian attributes this behaviour to the formation of an unstable complex anion $(AlF_6)^{---}$ between aluminium and fluoride ions; fluoride ions are slowly released when the Zr-Erio-Chrome cyanine-R lake is added to the reaction mixture.

It has been observed that the complex ion $(AlF_6)^{---}$ is not formed at slightly elevated temperatures (35°C) and hence the colour of the lake gets bleached rather instantaneously enabling estimation of fluoride even in presence of aluminium. Based on this, a method for the estimation of fluoride in presence of aluminium is described using Bausch & Lomb spectronic-20 Colorimeter.

25. Colorimetric Determination of Divalent Copper with 2-Mercapto-3-phenyl quinazol-4-one.

G. C. AMIN (Shahad), Kalyan.

A solution of 2-mercapto-3-phenyl quinazol-4-one in sodium hydroxide has been found to give yellow coloration or precipitate with divalent copper solution; this could be completely extracted with chloroform giving yellow solution which has been employed for the colorimetric determination of copper.

26. Simultaneous estimation of Cobalt and Nickel with 8-Hydroxy-quinoline.

S. K. K. JATKAR, N. V. DESHPANDE and A. J. MUKHEDKAR, Poona.

Co+++ and Ni++ form complexes with excess of 8-hydroxyquinoline in the ratio Metal : ligand : : 1 : 2. Co+++—8-hydroxyquinoline complex absorbs at 365 mμ and 700 mμ; while Ni++—8-hydroxyquinoline complex absorbs only at 365 mμ in HCl-acetone medium. Beer's law holds good in the concentration range 1 to 25 mg. of the metal per liter. This method is therefore used for the simultaneous estimation of Co+++ and Ni++.

27. Determination of Ferrous Iron in Uranium bearing Minerals.

P. MURUGAIYAN, Bombay.

Presence of uranium (IV) is a serious interference in the determination of ferrous iron in minerals and ores. It has been shown that this interference could be removed by dissolution of the sample in phosphoric acid medium, in the presence of which, ferric iron is not reduced by uranium (IV). The ferrous iron can then be determined by titration with methylene blue as an indicator. Results obtained with various synthetic mixtures containing iron (II), iron (III) and uranium (IV) have been presented. If uranium (VI) is present in a mineral, it will alter the ferrous iron content during the dissolution itself.

28. Application of the use of Auxiliary Complexing Agent in the Spectrophotometric study of the systems of Titanium with Sulphosalicylic Acid and Ethylenediaminetetraacetic Acid by Job's Method in Equimolar Solutions.

R. M. SATHE and CH. VENKATESWARLU, Bombay.

The composition of the complexes formed between titanium and sulphosalicylic acid in 5% H_2SO_4 and at pHs 3·1 and 5·0 have been determined by the

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Job's method in equimolar solutions. In the latter case, correct composition could only be obtained by using an auxiliary complexing agent to eliminate the troublesome side reactions of hydrolysis and polymerisation of the metal ion. The composition of the colourless Ti-EDTA complex has also been established by using sulphosalicylic acid as an auxiliary complexing agent. The stability constants for Ti-SSA system are derived from the known value of the Ti-EDTA system. From this, the stability constants for the Ti-oxalate and Ti-malonate systems are calculated.

29. Polarographic study of Indium Thiocyanate Complexes.

T. P. RADHAKRISHNAN and A. K. SUNDARAM, Bombay.

The polarography of indium in ammonium thiocyanate medium is studied. The variation of the half-wave potential of indium as a function of ammonium thiocyanate concentration has been studied at an ionic strength of 2·0 in perchloric acid-sodium perchlorate medium. The results are interpreted on the basis of complex formation of indium with thiocyanate. The estimated values of the overall constants for the complex ions $In(SCN)^{++}$, $In(SCN)_2^{+}$, $In(SCN)_3$, $In(SCN)_4^{-}$, $In(SCN)_5^{--}$, and $In(SCN)_6^{---}$ are $1{\cdot}2\times10^2$, $1{\cdot}6\times10^3$, $1{\cdot}75\times10^4$, $1{\cdot}7\times10^4$, $6{\cdot}5\times10^4$ and $6{\cdot}9\times10^4$ respectively.

30. Chromatographic Separation of Metallic Ions of the same group using Ethanol as solvent.

SHIB DAS BISWAS and ARUN K. DEY, Allahabad.

Attempts to identify and separate Ag (I), Hg (I), Pb (II), Hg (II), Bi (III), Cu (II), Co (II), Cd (II) As (III) Sb (III) Sb (V) Al (III), Cr (III), Fe (III), Zn (II), Mn (II), Ni (II), Cr (II), Ba (II), Sr (II), Co (II), in binary, ternary and quarternary mixtures of the same group of qualitative analysis by ascending filter paper strip chromotography has been made. Various concentrations of aqueous ethanol were tried and it was found that 50-60% ethanol gives good separations except in a few cases. The sequence of separation in mixtures has also been studied in detail.

31. Separation and Micro-identification of Anions using Weisz Ring Oven.

KAILASH NATH MUNSHI and ARUN K. DEY, Allahabad.

In 1954, Weisz devised the Ring Oven Technique for analysis of a number of cations in a single drop of a solution on a circle of filter paper. The chromatographic methods so far described for the separation and analysis of mixtures of anions require a lot of time. The present work describes a more rapid and new technique in which anions are separated chromatographically using the Weisz ring oven. Mixtures of micro-amounts of two, three or four of these anions can effectively be separated into distinct circular zones within 5 minutes. 60% ethanol, acetone and in some cases mixtures of both in a ratio 1 : 1 were used as solvents,

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32. Colorimetric Determination of Iron (III) with 2-Napthol 3:6-di Sulphonate.

SURENDRA NATH SINHA and ARUN K. DEY, Allahabad.

A method for the colorimetric determination of iron (III) with 2-napthol 3 :6 disulphonate (R-Salt) has been described. The composition of the chelate as determined by various methods using absorbance measurements is 1 :2 ($M Ke_2$) and the wavelength of maximum absorption is 580 mμ. The colour reaction is almost instantaneous. The coloured complex conforms to Beer's Law over an iron concentration of 0·37 to 20·16 p.p.m. The optimum pH range for the determinations is between 2·3 and 2·8 and temperature has no significant effect on the colour intensity. The sensitivity based on an absorption of 0·010 unit is 1·60 $\gamma/cm.^2$ (Sandell) and 16·00 γ/cm^2. (Practical). Interferences by a large number of added foreign ions have been investigated in detail. Most of the common ions are found to interfere and should, hence, be removed before the determinations are made.

33. Murexide (Ammonium purpurate) as an indicator in thorium-ethylene-diamine tetraacetic acid titrations.

SATENDRA PRASAD SANGAL and ARUN K. DEY, Allahabad.

The use of ammonium purpurate as an indicator for the complexometric determination of thorium with EDTA has been described. Titrations are possible upto a concentration 0·005M of thorium at all temperatures and at pH 2·5. Many of the anions and cations are observed to interfere in the titrations except silver(I), mercury(II), aluminium(III), arsenic(III), manganese(II), alkali metals and the alkaline earths. Estimation of thorium in presence of iron(III) is possible by masking the latter with ascorbic acid.

34. A Rapid Paper Chromatographic Separation of micro-amounts of metallic ions using Weisz Ring Oven Technique.

ERIC JOHN SINGH and Arun K. Dey, Allahabad.

A simple and rapid micro-analytical method for the separation of metallic ions of the same group of qualitative analysis has been described. To solutions of two to five metal ions, some ethylene diamine tetraacetic acid is added, a drop is spotted on a filter paper circle and separations are affected on the ring oven using water-ethanol as solvent. The separation and identification of a mixture can be accomplished within five minutes. The presence of the complexing agent is necessary, in general, to secure good separations. The sequence of the separations and the effect of the concentration of the complexing agent are considered.

35. Quantitative estimation of certain metals with 3, 5-Dibromo Anthranilic Acid.

K. S. BHATKI and M. B. KABADI, Bombay.

A substituted product of anthranilic acid-3,5-dibromo anthranilic acid has been studied from the point of view of its use in inorganic analysis. The sodium salt of the reagent is used for estimating copper, nickel, zinc and silver. The precipitate obtained in each case is weighed directly as the organo-metallic complex. The silver complex obtained with the reagent does not appear to be susceptible to the action of ordinary light and hence the estimation of silver can be accomplished without taking any special precautions as to the effect of light.

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36. A Highly selective method for Copper using Bis-Salicylaldehyde-ethylenediamine as Analytical Reagent.

B. R. SINGH and SATYA KUMAR, Nainital.

Copper precipitates quantitatively in the pH range of 8—13·5 as its Bis-Salicylaldehyde-ethylenediamine complex of formula $C_{16}H_{14}O_2N_2.Cu$ dried at 100—120°C. The complex is stable in presence of excess ammonia, 0·1 N alkali, ammonium salts and complexing agents as tartrate, citrate, sodium-thio-sulphate, fluoride, thiourea, triethanolamine and EDTA. In presence of tartrate and ammonia the ions of alkali metals, alkaline earths, Ag^{+1}, Tl^{+1}, Tl^{+3}, Pb^{+2}, Cd^{+2}, Co^{+2}, Mn^{+2}, Pd^{+2}, Al^{+3}, Cr^{+3}, La^{+3}, Ce^{+3}, Au^{+3}, Pt^{+4}, Ti^{+4}, Zr^{+4}, Th^{+4}, UO_2^{+2}, and anions as VO_3^{-1}, MoO_4^{-2}, WO_4^{-2}, CrO_4^{-2}, PO_4^{-3}, AsO_4^{-3} do not interfere. Ni^{+2} and Hg^{+2} are masked by tartrate, EDTA and ammonia; As^{+3}, Sb^{+3}, and Sn^{+2} are separated using fluoride as the complexing agent; at an alkalinity of 0·1 N caustic alkali in presence of tartrate As^{+3}, Sb^{+3}, Sn^{+2}, Bi^{+3}, Zn^{+2} and Fe^{+3} are separated. Fe^{+3} can also be separated using triethanolamine as the masking agent at a pH of about 13·0. In this manner copper can be separated from almost all the ions, thus affording a highly selective method for the determination of copper.

37. Two Dimensional Paper Chromatographic Separation of Food Colours.

P. N. SEN GUPTA and S. N. MITRA, Calcutta.

To obviate the difficulty of separation and identification of a mixture of food colours, a two-dimensional paper chromatographic technique, using 20 cm^2 Whatman No. 1 paper, has been found to be useful. To find out two suitable solvent mixtures for this purpose, Rf values of 20 food colours of which 13 are "permissible dyes" under the P.F.A. Act, 1954, have been determined using 8 solvent mixtures and employing ascending technique. The paper is rolled and tied in the form of a cylinder and the chromatogram is developed from a petridish containing solvent and covered with a bell jar. Total solvent front is 18 c.m. The developed chromatogram of each colour has been treated with a drop of Conc. HCl and 10% NaOH and also exposed to ultraviolet ray to determine the changes in the chromatograms.

For two-dimensional chromatography, N. Butyl alcohol/3N. Acetic acid/Alcohol (5 :5 :2) as solvent I and 2% Trisodium citrate soln. in 5% (W/v) Ammonia as solvent II have been found to be most suitable. A drop of solution of a mixture of 13 'permissible' dyes is taken at one corner end and chromatogram is developed upward with solvent I. The paper is dried and again rolled and tied in opposite direction and put in solvent II. With the rise of this solvent, the strip of first chromatogram is further resolved and each of the 13 colours takes definite positions on the paper and these are noted for identification and also the Rf of each colour with respect to two solvents have been determined.

38. Thorin (1-0-Arsonophenylazo 2-Naphthol 3:6 Disulfonic Acid) as a Reagent for the Determination of Calcium in Nuclear pure Uranium.

C. S. PADMANABHA IYER and G. M. VAIDYA, Bombay.

The calcium-thorin system is studied for the first time. The optimum condition for the complexation occurs at pH 8—8·8, the complex showing maximum absorbance at 530 mμ. The specific extinction coefficient of the complex is found

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to increase, depending on the concentration of acetone added to the system. The formula of the complex is found to be 1 :1.

Calcium in nuclear pure uranium metal is determined by using this reagent after a preliminary tributyl phosphate extraction to remove the uranium.

39. The Standardisation of Uvispek Spectrophotometer in the Region 220 mμ—500 mμ.

B. N. SRINIVASAN, Bombay.

The performance, that is the accuracy and reproducibility of the Uvispek spectrophotometer, was determined employing a standard alkaline solution of potassium chromate. The standard deviation values obtained, are compared with the collective data obtained on several Cary and Beckmann instruments in the region 220—500 mμ. The spectrum of alkaline potassium chromate shows a new absorption peak at 210 mμ having log e_{10}=4·10.

40. A study of some carriers and internal standards for the Spectrographic determinations of the impurities in Thoria by the carrier distillation technique.

K. SRIKAMESWARAN, Bombay.

In order to select a suitable carrier for the estimation of some impurities in thoria by the carrier distillation technique, comparative study of a few carriers has been made. On the basis of this comparison, silver chloride, 5% by weight, has been found to be the most suitable carrier. By the moving plate technique, the volatilization characteristics of the impurity elements have been compared. The spectral lines of cobalt 2424·9A° and gallium 2500·7A° have been found to be satisfactory internal standard lines for the spectrographic estimation of the impurities.

41. Spectrographic determination of traces of Tantalum and Titanium in Niobium Oxide and of Titanium and Niobium in Tantalum Oxide.

L. C. CHANDOLA and U. R. N. SWAMY, Bombay.

A spectrographic method is described for the estimation of tantalum oxide and titanium oxide in the ranges 0·01—2% and 0·05—2% respectively on a niobium oxide base and also for the estimation of niobium oxide and titanium oxide in the ranges 0·025—1% and 0·025—2% respectively on a tantalum oxide base. Intermittent A.C. arc excitation has been utilised with a Hilger E 492 large quartz spectrograph. In niobium oxide matrix Nb 3081·77A° and Nb 2683·22A° are used as the internal standard lines for Ti 3078·64A° and Ta 2685·11A° analysis lines respectively. In the tantalum oxide matrix the lines Ta 2943·77A° and Ta 3182·57A° are used as the internal standard lines for Nb 2950·88A° and Ti 3186·45A° analysis lines respectively.

42. Spectrographic analysis of rare earths in Uranium and Thorium.

T. R. SARANATHAN and K. KAMALA, Bombay.

A spectrographic method for the estimation of Pr, Nd, Tb, Ho, Tm and Yb present in ppm levels in pure uranium and thorium is described. A d.c. arc excita-

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tion between graphite electrodes is used with a large quartz littrow mount spectrograph. Ti (3370·4A°) is used as the internal standard for Tb, Ho, Tm and Yb in the concentration range 0·1—2 ppm and La (4315·90A°) for Nd and Pr in the concentration range 0·2—4 ppm on 50 gms sample. The spectral lines used with the detection limits are given below :

Nd 4303·570, Pr 4225·327	... 0·2 ppm
Tb 3323·40, Tm 3362·61, Ho 3398·98, Yb 3464·37 ...	... 0·1 ppm

43. ThB-ThC : A new Genetically related pair of Radionuclides for the growth-decay study.

P. P. PAREKH and M. SANKAR DAS, Bombay.

A new pair of genetically related radionuclides viz., ThB (Pb—212) —ThC (Bi—212) has been recommended for the study of

(1) The growth of a radioactive daughter from its initially pure parent species, and

(2) The rate of decay of the pure radioactive daughter.

Some of the salient features of the suggested system are the easy-availability of the source from which the above mentioned pair of radionuclides can be obtained; the short duration of the experiment (about 15 hours) in which time one can study

(1) the growth of the daughter product,
(2) the time of maximum activity of the mixture as well as daughter,
(3) the rate of decay of the mixture of radionuclides after attaining radioactive equilibrium, and
(4) the measurement of half-life of a simple radioactive decay of the pure daughter element.

The advantages of this pair over the systems in general use have been discussed.

44. Job's Method of continuous variation in non-equimolar solutions—effect of an Auxiliary Complexing Agent.

R. M. SATHE and CH. VENKATESWARLU, Bombay.

The complex formation between titanium and protocatechuic acid has been reinvestigated by using the Job's method of continuous variations in non-equimolar solutions in the presence of oxalic acid as an auxiliary complexing agent. The relative reliabilities of the method in the presence and absence of the auxiliary complexing agent are discussed by comparing data obtained on the same system.

45. A Simplified and Rapid Procedure for Determination of Uranium in Low Grade Ores.

A. J. PATKAR and B. L. RAO, Bombay.

A rapid method for the determination of uranium in low grade ores is described and is based on opening of the ore with potassium acid fluoride and taking the melt in saturated aluminium nitrate acidified with nitric acid. Fluoride and phosphate are complexed by aluminium nitrate. Separation of uranium is based on Burstall and Wells' cellulose chromatographic method and the final estimation

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is done by extraction of the DBM-uranium complex in carbon tetrachloride after complexing the residual elements with EDTA. Excellent results are obtained in U_3O_8 concentration as low as 0·001% in a variety of simple and complex minerals and ores.

46. Determination of Oxygen in Uranium Oxides.

K. A. KHASGIWALE, K. N. SIRIAH and M. SUNDARESAN, Bombay.

The low pressure method of estimating oxygen in uranium oxides higher than stoichiometric composition $UO_{2\cdot000}$ has been modified especially in respect of purification of hydrogen and new design of reduction cell to give an accuracy of ±1·5% on the excess oxygen in case of lower uranium oxides.

47. Chromatographic Analysis of Dyes in Pharmaceutical Preparations.

H. L. BAMI, Calcutta.

Several synthetic dyes are used both as colouring agents and bactericidals in various drug and pharmaceutical preparations. Amongst these, methylene blue (medicinal), acriflavin, proflavin, brilliant green and gentian violet have been commonly employed in eye lotions and other local antiseptic preparations. Based on partition chromatography on cellulose column using 30 : 70 benzene butanol mixture saturated with I N acetic acid as eluent, methylene blue and acriflavin components of several commercial eye lotions have been separated. Subsequently, the eluted dyes were colorimetrically analysed employing standard curves prepared for each dye similarly. Minimum accuracy of the technique developed, was ±10% as verified by duplicate analysis of known dye mixtures. Analysis of commercial samples of eye lotions has also revealed that the concentration of dyes was sometimes not properly adjusted during manufacture. The present analytical technique is being extended to other pharmaceutical preparations containing one or more of these dyes.

INORGANIC

48. Hydrazine Fluoride complex of Uranium (IV) and its Thermal Decomposition.

BALARAM SAHOO, B. TRIPATHY and D. PATNAIK, Cuttack.

Solar energy has been used for the photochemical preparation of hydrazine uranium (iv) fluoride complex when a solution of uranylnitrate in hydrofluoric acid, hydrazine and alcohol is exposed to sunlight, a bright green crystalline compound of hydrazine uranium (iv) fluoride $N_2H_5FUF_4$ is obtained in the anhydrous state. The thermal decomposition of the compound in vacuum at about 400°C readily gives anhydrous uranium tetrafluoride. Of the various methods in use for the preparation of uranium tetrafluoride the method incorporated, appears to be simple, convenient and eliminates many of the mechanical operations.

49. Differential behaviour of Ammonium Uranium (IV) Fluoride complex towards Hydration.

BALARAM SAHOO and D. PATNAIK, Cuttack.

Anhydrous and hydrated ammonium uranium (IV) fluoride complex have been prepared by following different methods for reduction. The difference in behaviour

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of the anhydrous complex towards water has been attributed to different structural forms. It is suggested that in energetic and vigorous reduction processes, such as electrolytic and nascent hyposulphurous acid lattice type anhydrous compound of NH_4F, UF_4 is formed while with less energetic reduction processes such as photolysis and copper catalysed sulphur dioxide reduction hydrated co-ordination compound NH_4F, UF_4, H_2O is obtained.

50. Preparation of Uranium (IV) Succinates and Uranium (IV) Tartarate.

K. C. SATAPATHY, BALARAM SAHOO and D. PATNAIK, Cuttack.

Uranium (IV) succinate having the formula $UO(C_4H_4O_4)$, $3H_2O$ has been isolated by the photochemical reduction of uranyl formate and succinic acid in presence of alcohol. Sun light has been used as the source of energy. A different compoud having the composition $UO(C_4H_4O_4)$, $U(C_4H_4O_4)_2$ has been prepared by the action of succinic acid on uranium (IV) oxycarbonate.

A tartarate compound of uranium (IV) having the composition $UO(C_4H_4O_6)$, $U(C_4H_4O_6)_2$, $5H_2O$ has been prepared by photochemical method.

51. A Note on the Preparation of Uranium Dioxide.

C. R. DAS, B. SAHOO and D. PATNAIK, Cuttack.

The thermal decomposition of Uranium (IV) oxyacetate ond Uranium (IV) oxyformate has been studied in vacuum and in an atmosphere of ammonia at about 450°c. It has been found that with oxyacetate the product of decomposition in vacuum contains fifty per cent uranium dioxide, which is enhanced to ninety percent when decomposition is carried out in presence of ammonia. However with oxyformate, ninety per cent yield of uranium dioxide in vacuum is raised to ninety-five percent when heating is conducted in atmosphere of ammonia at 450°C.

52. On 4-Nitrophthalates of Thorium and Uranium (VI) and their separation.

G. S. RAO, N. S. K. PRASAD and A. J. SINGH, Bombay.

Thorium and uranium (IV) have been found to form insoluble compounds with 4-nitrophthalic acid under different conditions of precipitation. The compounds have been prepared in crystalline state and their chemical analysis shows that uranium forms uranyl diammonium dinitrophthalate $UO_2[C_6H_3(COO)_2NH_4NO_2]_2$ while thorium forms dinitrophthalate $Th[C_6H_3(COO)_2NO_2]_2$. Advantage has been taken of the fact that these precipitates are formed under different conditions of acidity, concentrations of the reagent and metal ion, in separating the two elements. This paper deals with the nature of compounds formed by uranium (VI) and thorium with 4-nitrophthalic acid and the conditions of their separation using this reagent.

53. Complex compounds of Copper with Mono-, and Di-, N-Phenyl Thioureas.

S. N. BANERJEE, Kharagpur, and A. C. SUKTHANKAR, Bombay.

Several complex compounds of mono-, and di-, N-phenyl thioureas with copper salts *viz.* (i) CuOH. Ph.Th. 0·5 H_2O, (ii) CuOH.2PhTh. H_2O, (iii) 2CuCl. 5PhTh, (iv) Cu_2SO_4.6PhTh, (v) $CuNO_3$. 4PhTh.HNO_3.3CH_3COCH_3, (vi) CuOH.PhThPh,

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(vii) Cu_2SO_4.2PhThPh, (viii) CuCl.2PhThPh have been prepared and their properties studied. Of these complexes, three (Nos. (ii), (iii) and (iv)) have already been reported, and the rest are described probably for the first time. ('Th' represents NH_2CSNH_2; 'PhTh', $C_6H_5NHCSNH_2$ and 'PhThPh', $C_6H_5NHCSNHC_6H_5$ molecules).

From a critical study of the copper-thiourea complexes in general, it has been shown that the tendency for coordination of thiourea with cuprous ion, decreases with an increase of the number of substituents in the parent thiourea ligand *viz.* "Thiourea>Mono-Phenyl Thiourea>Mono-Acetyl Thiourea>Di-phenyl thiourea".

Further investigations on this line with other substituted thioureas are under progress.

54. Complex compounds of Copper with mono-N-acetyl-, and of Silver with mono-, and di-, N-phenyl Thioureas.

S. N. BANERJEE, Kharagpur and A. C. SUKTHANKAR, Bombay.

The following compounds *viz.* (1) CuCl. 2AcTh, (2) Cu_2SO_4. 4AcTh, (3) 2Cu NO_3. 5AcTh.2HNO_3, (4) CuOH.3AcTh, (5) 2$AgNO_3$. 5AcTh, (6) $AgNO_3$. PhTh, and (7) $AgNO_3$. PhThPh have been prepared and their properties studied. Of these complexes nos. (2) and (6) have already been reported, and the rest are presented probably for the first time. ('Th' represents NH_2CSNH_2; 'PhTh', $C_6H_5NHCSNH_2$; 'PhThPh', $C_6H_5NHCSNHC_6H_5$ and 'AcTh', $CH_3CONHCSNH_2$ molecules).

Attempts are being made to prepare similar compounds with other metal salts under various experimental conditions, and to investigate their stability constants, in order to solve the problem of constitution of metal—thiourea complexes of various types.

55. Metal Complexes of 1-phenyl-3-α-pyridyl triazene.

A. K. MAJUMDAR and S. C. SAHA, Calcutta.

Stable complexes of 1-phenyl-3-α-pyridyl triazene (PPTh) with Cu (I), Cu (II), Ni (II), Co (II) and Pd (II) were isolated. These complexes are either insoluble or has very little solubility in organic solvents. Ni (II), Co (II) and Cu (II) form compounds of empirical formula $M(PPT)_2$. An octahedral structure for the Ni (II) complex was suggested based on its dimeric nature, magnetic moment and high stability. 1-phenyl-3-α-pyridyl triazene functions as a tridentate ligand and acts as a bridge between two nickel ions. Magnetic moments of the Cu (II) and Co (II) complexes suggest the same type of structure as that of Ni (II). But the point could not be clearly proved because of the inability to determine their molecular weights.

The quadricovalent Pd (II) complexes, Pd(PPT).X, and the cuprous complex, Cu(PPT).Py, are diamagnetic. A polymeric bridged structure, as suggested for palladium (II) chloride, and a linear structure have been proposed for the respective complexes. The cuprous complex being unstable changes to green cupric compound on standing in pyridine solution. Attempts to prepare Co (III) complex starting from hexamine Co (III) chloride always led to the formation of a Co (II) compound.

For the elucidation of the structure of the above complexes, spectral studies, visible and infrared, are underway.

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56. Ion-Exchange study of thiocyanate complexes. Part I—Cation-Exchange resin.

A. K. MAJUMDAR and B. K. MITRA, Calcutta.

Cation-exchange behaviour of the thiocyanate complexes of Hg (II), Cu (II), Cd (II), Zn (II), Pb (II) and Bi (III) have been studied. Stability of the complexes being different under certain thiocyanate concentrations, effective separations of the said elements from each other have been achieved. The metal ions after been adsorbed on the Amberlite—IR-120 (NH_4+ form) resin are eluted with thiocyanate of varied concentration. Thus, while Hg (II) is completely eluted with a 0·5 percent solution of ammonium thiocyanate, Cu (II), Cd (II) and Zn (II) require, respectively, 2, 3 and 4 percent of the said solutions for their complete elution. For Bi (III), a 6·0 per cent solution of the thiocyanate, acidified with nitric acid to 0·1 (N), is highly satisfactory. Pb (II) is unaffected and remains on the resin bed, from which it can, however, be eluted with 6·0 percent ammonium acetate solution.

57. Studies on Transitional Metal Complexes. Part I—Quadricoordinate Ni^{II} complexes.

A. K. MAJUMDAR and B. C. BHATTACHARYYA, Calcutta.

Co-ordination complexes of Nickel (II) with a tridentate schiff's base, obtained by coupling salicylaldehyde with anthranilic acid, have been studied. The composition of the complexes is $Ni(C_{14}H_9O_3N)X$ where $X=NH_3$, $C_2H_5NH_2$, $(C_2H_5)_2NH$, C_5H_5N, $2H_2O$, $1/2\,[NH_2(CH_2)_2NH_2]$ and α-, β- and γ-picolines. The study of the magnetic moment of these complexes distinguishes two types of structures. $Ni(C_{14}H_9O_3N)NH_3$ and $[Ni(C_{14}H_9O_3N)]_2(en)$ are square planar being diamagnetic and are not susceptible to oxidation. The compounds $Ni(C_{14}H_9O_3N)X$, when $X=2H_2O$, C_5H_5N and α-, β- and γ-picolines, are paramagnetic with moments corresponding to the presence of two unpaired electrons. This indicates either a tetrahedral or a distorted octahedral configuration. The reason for the low moment of $Ni(C_{14}H_9O_3N)$-$C_2H_5NH_2$ (1·0) and $Ni(C_{14}H_9O_3N)$ $(C_2H_5)_2NH$ (1·75) is not yet known. The investigation is in progress to elucidate the structures fully.

58. Separation of niobium and tantalum from each other with Benzohydroxamic acid and Phenyl-acetyl-hydroxamic acid.

A. K. MAJUMDAR and BIJOLI K. PAL, Calcutta.

Benzohydroxamic acid and phenyl-acetylhydroxamic acid have been utilised separately for affecting the separation of tantalum from niobium. These reagents, though fail to precipitate either niobium or tantalum from tartrate and citrate solutions, give quantitative precipitation of tantalum from oxalate medium. Niobium, however, remains in solution, from which it can be recovered by quinaldinohydroxamic acid or N-benzoyl-N-phenylhydroxylamine. Thus separated the tantalum precipitate needs ignition to oxide for the final weighing, the niobium precipitate can be weighed after drying at 110°C or after ignition to oxide.

Benzohydroxamic acid can be used at a pH between 4·0 and 6·4 for the complete separation of tantalum from niobium present in a ratio of 1 :18 to 20 :1 by a single precipitation, while phenylacetylhydroxamic acid premits under a pH of 4·5 to 6·2 a satisfactory separation of tantalum from niobium by single precipitation when they are present up to a maximum ratio of 1 :8. For other ratios dissolution and reprecipitation of tantalum are necessary.

Titanium, zirconium, tartrate and citrate seriously interfere.

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59. Basic Carbonate of Aluminium.

MANIKLAL SEN GUPTA, Calcutta.

Precipitation of aluminium sulphate with sodium carbonate yields a product containing varying amounts of aluminium hydroxide, sodium bicarbonate and carbon dioxide. The carbon dioxide content is influenced by conditions of precipitation, such as excess of alkali used in precipitation, the concentration of the solutions and the temperature. The extent of coprecipitation of sodium bicarbonate increases with increasing excess alkali or temperature of precipitation and decreases with dilution; the carbon dioxide associated with the alumina on the other hand decreases with too much excess alkali, with dilution as well as with increased temperature. Under the best favourable conditions, the carbon dioxide content, allowing for that combined with residual alkali is about 16 g. per 100 g. Al_2O_3. This product is fairly stable at 40°C, and heating causes a rather stepwise elimination of carbon dioxide. The presence of carbon dioxide ensures ready solubility of the dried precipitate in dilute acids, the solubility decreasing as the carbon dioxide content is lowered.

60. Extraction of Germanium from Fly-ash.

G. S. RAO, K. M. ABUBACKER, T. KESAVA DAS and C. T. MEHTA, Bombay.

The importance of germanium in transistor technology and the desirability of developing it in this country instigated a search for the sources of germanium and the possibility of extracting the same from such sources which are available. The only source of germanium so far discovered is the fly-ash (or flue dust) in which it gets concentrated under suitable conditions when coal samples containing germanium are burnt. Such fly-ash samples were collected from various power houses and factories and analysed for their germanium content. The method of extracting germanium from the samples by direct chlorination was studied in detail and optimum conditions for maximum recovery from 500 gm. lots have been established. The percentage recovery on this scale was found to be between 75 and 85 percent.

61. Studies on Peroxy Titanium Malonate.

G. V. JERE and C. C. PATEL, Bangalore.

During our studies on peroxide chemistry of titanium, an orange red complex—peroxy titanium malonate—was prepared for the first time by reaction of freshly precipitated titanium hydroxide with excess of hydrogen peroxide and malonic acid. The complex is a true peroxy compound and not a perhydrate. The molar composition of the complex is, Ti : Malonate : O_{peroxy} · H_2O as 1 : 1 : 0·88 : 3, suggesting the composition of the compound as $TiO_2(OOC.CH_2.COO).3H_2O$. Several physico-chemical studies have been carried out. The absorption maximum for the complex is at 378 mμ (log ε = 2·91). Job's method of continuous variation gives Ti : O_{peroxy} ratio as 1 : 1, but the peroxy oxygen content in the solid complex is lower than the stoichiometric value because of the gradual loss of peroxy oxygen from the complex. Of the three water moles, two are coordinated to central titanium, while the third is loosely held and can be removed under vacuum. The complex is amorphous and diamagnetic. The differential thermal curve shows an exothermic peak at 100°C for the decomposition of the peroxy group from the complex. The infrared spectrum of the complex gives the bands at—3175(vs),

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1667(vs), 1610(vs), 1443(s), 1370(s), 1290(w), 1167(w), 1041(m), 909(s), 891(w), 810(m) and 721 (m) cm−1. These bands have been characterized. The dissociation constants of the malonate group and of the peroxy group are, $2{\cdot}56\times10^{-3}$ and $2{\cdot}8\times10^{-5}$ respectively. From the above studies, the structure of the complex has been assigned.

62. Recovery of Silver in the laboratory by Hyposulphurous Acid.

N. C. NAIK, B. SAHOO and D. PATNAIK, Cuttack.

Extraction of silver from silver halides has been achieved by a convenient method. Nascent hyposulphurous acid has been used as the reducing agent. Silver is obtained quantitatively in the fine state which can be dissolved in moderately concentrated nitric acid and can be crystallised in the form of the silver-nitrate.

63. Preparation of ideal γ-MnO_2, for dry battery manufacture.

A. N. CHOWDHURY, B. DAS SARMA and G. P. BASU CHAUDHURY, Calcutta.

A method for the preparation of ideal γ-MnO_2 has been described. This variety of manganese dioxide is believed to be responsible for the long cell life, higher and consistent amperage and voltage of all dry batteries. The method consisted of slow reaction of concentrated potassium permanganate solution with concentrated nitric acid at 80—90°C with constant stirring. The material washed and dried in air was found to contain ideal γ-MnO_2 structure by X-ray investigation. This material mixed with nine times its weight of non- γ manganese ores from various Indian mines produced batteries of excellent quality as compared to batteries wtih imported, synthetic γ-MnO_2 used in battery industry. This work shows that all of the synthetic γ-MnO_2 imported by Indian dry-battery manufacturers can be locally prepared.

64. Studies on the composition and stability of Chelate formed between Zirconium and Sulpho-dichloro Hydroxy-dimethyl Fuchson Dicarboxylic Acid.

ROSHAN LAL SETH and ARUN K. DEY, Allahabad.

A detailed study has been made on the composition and stability of the chelate formed between zirconium and sulpho-dichloro hydroxy-dimethyl fuchson dicarboxylic acid (Chrome Azurol S) using absorbance and electrical conductance measurements. The composition of the chelate has been studied by (i) Job's method of continuous variations, (ii) the mole ratio method and (iii) the slope ratio method. The results have further been corroborated by electrical conductance measurements. The chelate has its maximum absorption at 530 mμ. The stoichiometry of the chelate has been found to be 1 : 1. It is stable between pH 1·5 and 5·5. The value of the stability constant (log K) as determined by the continuous variations method and the mole ratio method using absorbance data is found to be $4{\cdot}9\pm0{\cdot}1$ and $5{\cdot}0\pm0{\cdot}2$ respectively at temperature 25°C and pH 2·5. The free energy change of formation calculated from the two values of log K comes out to be $-6{\cdot}72\pm0{\cdot}14$ and $-6{\cdot}85\pm0{\cdot}28$ K Cals. respectively.

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65. Studies on complex formation between beryllium ions and morin in solution.

(KUM.) S. R. JAGASIA and B. C. HALDAR, Bombay.

The formation of a complex compound containing beryllium and morin in the ratio 1 : 1 has been shown by thermometric and conductometric titrations of morin with beryllium surfate. The composition of the complex has been confirmed by Job's Continuous Variation method.

66. Chelate formation of ferric ion with 2:naphthol-3:6-disulphonate—A spectrophotometric study.

SAMIR K. BANERJI, Pilani.

A spectrophotometric and conductometric investigation of the chelate formed between iron (III) and 2-naphthol-3 : 6-disulphonate (R-salt) has been made. The composition as determined by the method of continuous variation is found to be $Fe(RAS)_2$. The chelate has been found to be stable between a pH 2 and 4, and the investigations have been carried out in that pH range. The chelate is deep blue in colour and has a λ_{max} at 580 mμ. The stability has been calculated by a method described earlier and the value of logK is $8{\cdot}77 \pm 0{\cdot}14$ and the value of free energy of formation is $-12{\cdot}10 \pm 0{\cdot}20$ kcals at 25°C.

67. Kinetics of Reduction of Rhenium (V) by Tin (II) in Hydrochloric Acid Media.

M. S. MOHAN, Calcutta and D. BANERJEA, Durgapur.

The kinetics of reduction of rhenium (V) to rhenium (IV) by tin (II) has been studied spectrophotometrically in hydrochloric acid media (3—6 M.). The reaction has been found to be of the first order with respect to both rhenium (V) and hydrochloric acid and has an order of 0·5 with respect to tin (II); it is independent of tin (IV). A reaction mechanism has been suggested to explain the observed facts. It is necessary to assume that in hydrochloric acid media tin (II) exists chiefly as a binuclear chloro-complex and the reduction takes place through transfer of protons from (mononuclear) chlorostannous acid to the rhenium (V) in two steps. Activation energy of the process has been determined as usual, the value being 10·4 k. cal.

68. Association of Metallic Ion with Azide : Polarographic Study.

I. P. SINGH, Calcutta and D. BANERJEA, Durgapur.

The association of zinc, cadmium and thallous ions with azide has been studied polarographically by the method of DeFord and Hume (J. Am. Chem. Soc., *73*, 5321, 1951) in aqueous solution at 25°C and at a constant ionic strength (μ, 2) in sodium perchlorate medium. The various species which appear to be present in the solutions and their overall formation constants are given below : ZnN_3^+, 4·8; $Zn(N_3)_2$, 10·3; CdN_3^+, 7·8; $Cd(N_3)_2$, 26 and TlN_3, 2·5. The results indicate that azide has a weak complexing ability.

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69. A New Arrangement of the Periodic Table of the Chemical Elements—Part V.

V. S. PATEL, Betul, U.P.

In this paper certain explanations have been incorporated in view of the critical suggestions on the previous four parts of the new circular arrangement on the following lines :—

(1) A perfect increasing serial order has been maintained in this circular system.

(2) The breaking of the zero group and the VIII group is not necessary except for convenience.

(3) The electronic configuration of the elements is also kept in mind.

(4) The position of hydrogen in the centre of the table, and the gradation in the electropositive and electronegative nature of the elements, have been pointed out.

This is rather an effort to depict a more natural periodic arrangement of the atoms represented in the pattern of lines of force and equipotential surfaces.

70. Study of the Compound formed during the Oxidation of Mercurous Nitrate by Potassium Persulphate.

J. C. GUPTA and S. P. SRIVASTAVA, Naini Tal.

During the kinetic studies of the reaction between mercurous nitrate and potassium persulphate, it was observed that solid compounds are formed at high concentration of the reactants in suitable nitric acid concentration. With increasing concentration of nitric acid, the amount of the solid decreases so much so that at greater concentrations of the acid, no solid separates out. Ordinarily, there seem to be two types of precipitates, one which is yellow in colour, formed at lower concentrations of the acid, and the other which is white with slight tint of greyness, formed at higher concentrations of nitric acid. Both types of precipitates are affected by light and boiling water and both of them contain mercurous, mercuric and sulphate ions. It is also observed that the yellow precipitate is more easily soluble in nitric acid than the white-grey precipitate. Both type of precipitates do not contain any water of crystallisation.

Further work to establish the chemical composition of these precipitates is in progress.

71. Resolution of Rhodium (III) Trisbiguanidinium and Iridium (III) Trisbiguanidinium Complexes.

S. P. GHOSH ond A. I. P. SINHA, Patna.

Rhodium (III) trisbiguanidinium chloride and Iridium (III) trisbiguanidinium chloride have been resolved into their optical isomers by forming diastereoisomers with d-tartrate. In both cases the leavogyrate forms the less soluble variety. The molecular relations for Rhodium (III) trisbiguanidinium chloro-d-tartrate and Iridium (III) trisbiguanidinium chloro-d-tartrate of $[M]_D = 951°$ and $[M]_D = 893°$ respectively. The chloride, nitrate and sulphate of both laevo- and dextro- series of each metal-complex ion have been prepared and their rotations measured. The salts are extremely stable optically and do not show appreciable racemisation even on boiling with active charcoal for several hours.

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72. Thermal Decomposition of Metal Biguanide Complexes.

S. P. GHOSH and A. I. P. SINHA, Patna.

Thermal decomposition of Copper (II), Nickel (II), Palladium (II)-bisbiguanidinium chloride and Cobalt (III),- Rhodium (III)-, and Iridium (III)-trisbiguanidinium chloride has been studied thermogravimetrically. With a heating rate of 4°/minute the first three, hydrates, lose their water of crystallisation between 60-90°. The first decomposition of the complexes proper starts at 218°, 250°, 268°, 265°, 320° and 330° respectively. In case of copper, nickel and cobalt complexes a definite break in the weight-loss curve is observed at points corresponding to the loss of one molecule of ammonia per biguanide molecule attached to the central metal atom. In the cobalt series the decomposition temperature evidently increases with the electronegativity of the metal. This order is also followed in the case of nickel and palladium. The behaviour of the copper complex is rather anomalous in two respects : (i) though thermodynamically copper (II)- is more stable than the nickel (II)-biguanide-complex the order is reversed in respect of thermal stability, (ii) the detachment of the two ammonia molecules from the two biguanide molecules takes place distinctly in two steps, one molecule being evolved very rapidly at 218° and the other rather slowly up to 240°. The final residue at 600-700° is generally the oxide of the metal but in case of copper and palladium complexes the residual weight level indicates the presence of a little reduced metal as well.

73. Uni-Valent Manganese Complex.

D. V. RAMANA RAO, Cuttack.

Dimanganese decacarbonyl reacts with diarsine under optimum conditions to form a diamagnetic dimer, $[Mn(CO)_3\ Diars]_2$ and a paramagnetic monomer. When titrated spectrophotometrically with iodine in chloroform, both the substituted manganese carbonyls react without any loss of carbon monoxide (as measured by gas burette), a sharp end point occurring after one equivalent of iodine has been added. The compound, $Mn(CO)_3\ (Diars)_1$, was isolated in pure condition.

The product is a non-electrolyte and is diamagnetic. The compound in chloroform solution shows three peaks (C-O stretching vibration) in the infrad red spectrum at 2032 (w), 1957 (s) and 1905 (s) cm^{-1}. Since Mn(I) has an effective $3d^6$ electronic configuration, a six-covalent, spin-paired complex utilising $3d^2 4s 4p^3$ orbitals is expected to be diamagnetic. It is thus clearly an octahedral spin-paired complex of Mn (I).

74. Studies on Periodic Formation : Part III—Effect of various factors on the time and distance relationship during silver chromate precipitation in Gelatine.

A. C. CHATTERJI and R. M. BHATNAGAR, Lucknow.

The process of Liesegang ring formation during silver chromate precipitation, when silver nitrate was diffused in gelatine medium impregnated with potassium chromate, was studied under a microscope. Morse and Pierce equation (i.e. $x+\alpha/\sqrt{T}=K$, where x is the distance of the ring from the first ring, T is the time of formation, α=distance of the quasi zone and K is a constant) was verified by (a) changing the concentration of the precipitating agent, (b) varying the concentration of the diffusing electrolyte, and (c) adding the electrolyte KNO_3. The following values of K were obtained. Concentration of the Gelatine=2%.

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K. values

Diffusing agent	Precipitating agent		
	N/25 K_2CrO_4	N/50 K_2CrO_4	N/50 K_2CrO_4+0·1N KNO_3
1. 0·02 grm. crystal of silver nitrate	0·0028	0·0035	0·0050
2. 0·02 ml. of 2N silver nitrate	0·0024	0·0027	0·0039
3. 0·02 ml. of 1N silver nitrate	0·0019	0·0023	0·0024
4. 0·02 ml. of 0·5N silver nitrate	0·0015	0·0016	...

From the table it is clear that the value of K decreases with the decrease in the concentration of the diffusing agent and increases with the decrease in the concentration of potassium chromate. In the presence of electrolyte (KNO_3) the values of K decreases with decrease in the concentration of silver nitrate.

The plot of X against $\sqrt{T}$ was linear; the slope increased with decrease in the concentration of the diffusing electrolyte. Attempts were made to check the validity of other equations.

75. Spectrophotometric Studies on the Zirconium Complex of 2-(3, 6-Disulfo-8-hydroxynaphthylazo)-1, 8-dihydroxynaphthalene-3, 6-disulfonic Acid.

SACHINDRA KUMAR DATTA and SACHINDRA NATH SAHA, Coochbehar.

A chromotropic azo dye : 2-(3, 6-disulfo-8-hydroxynaphthylazo)-1, 8-dihydroxy-naphthalene-3, 6-disulfonic acid, abbreviated as DSNADNS has been prepared from 1-amino-8-naphthol-3, 6-disulfonic acid and chromotropic acid. This dye has been employed earlier for the spectrophotometric determination of thorium. The dye also forms a bluish-violet insoluble complex with zirconium at high acid concentration. The precipitation of zirconium complex being quantitative under specific conditions, the dye may be adopted for the gravimetric determination of zirconium. The violet complex of zirconium is insoluble in all organic solvents commonly used for solvent extraction work but is soluble in a number of liquid organic bases and solutions of ammonium salts in water showing pink to violet colouration. Spectrophotometric studies as to the nature of the complex in pyridine, triethanolamine ammonium acetate, oxalate and carbonate solutions have been made with a view to develop analytical applications of these materials. The zirconium chelate in most of the ammonium salts and also in pyridine solution exhibit very similar absorption spectra which are almost identical to those of the free dye in such solvents, indicating thereby a decomposition of the complex in such solutions. But the solutions of the complex in ammonium carbonate and triethanolamine appear to be fairly stable. The absorbance peaks of the dye in these solutions occur at 500 and 520 mμ respectively, while the complex in triethanolamine and ammonium carbonate both shows absorbance maxima at 540 mμ. The solution of the complex in these two solvents obeys Beer's law within concentration range 4 to 25 mg. of zirconium per litre. The molar absorbance coefficients of the complex in triethanolamine and ammonium carbonate are respectively 686 and 823, which indicate poor sensitivity. The solution of the complex in the former is more stable than

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that in the latter. An analytical procedure for the spectrophotometric determination of zirconium, with little interference from foreign ions, in triethanolamine has been developed.

76. Complex formation between Uranyl Acetate and Gluconic Acid.

S. S. LAL, Saugor.

The complex formation between uranyl ions and gluconic acid was studied following the Hob's method of continuous variation and also the monovariation method. The stoichiometry of the complex was determined by continuous variation method using three different sets of equimolar solutions of uranyl acetate and gluconic acid, namely, M/20, M/30 and M/40. The index property used was conductivity. Both conductance and pH measurements were taken in the case of the monovariation method. The experimental results were in complete accord and established the formation of a 1 : 1 complex between uranyl and gluconate ions. The complex may be represented by the formula ($UO_2.C_6H_{10}O_7$).

77. Studies in the complex formation of Thallium compounds with Thiourea. Part I. Complex compounds of Thallous Nitrate ($TlNO_3$), Thallous Nitrite ($TlNO_2$), and Thallous Hyponitrite (TlNO), with Thiourea.

V. T. OZA and C. J. TRIVEDI, Visnagar.

No attempt has been made in the past to prepare complex salts of hyponitrites. It is a well known observation that when a solution of thiourea is added to a solution of silver nitrate white precipitate soluble in excess is obtained which slowly turns brown on standing. Same observation is met with the solution silver nitrite but the brown or black precipitate results in slightly more quicker manner. However if a solution of thiourea is added to a freshly precipitated silver hyponitrite in water free from any impurity a black precipitate is immediately formed, at room temperature.

Complexes formed by addition of thiourea solution to the solutions of thallous nitrate, thallous nitrite, and thallous hyponitrite are crystalline needle shaped compounds. Out of these three complexes only one having the formula $TlNO_3$.4tu. is known. From the thallium content determination it is found that the rest of these three compounds have also the same general formulae $TlNO_2$.4tu. and TlNO.4tu., respectively. Nitrate and nitrite complexes are stable in hot solutions and can be easily recrystallised from the same, while the last one is unstable in hot solution decomposing into thallous sulphide, which probably shows that it has got a dimeric formula.

78. Thermal Decomposition of Thallous Hyponitrite.

V. T. OZA and C. J. TRIVEDI, Visnagar

The Thermal decomposition of Thallous Hyponitrite is not investigated in past. The following are the important observations :

(1) It begins to decompose at 156°C but very slowly.
(2) When heated between 100°C and 140°C it changes its colour from orange yellow to brownish black, and during this change no decomposition takes place.

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(3) In solubilities etc., it is the only hyponitrite which is appreciably soluble in water next to alkali hyponitrites. Its solution is only freely hydrolysed in water at room temperature, the hydrolysis is appreciable at high temperature.

(4) Its purity can be estimated by titrations with mineral acids as it could be done with sodium hyponitrite, but titration can be carried out at room temperature.

79. Use of Bright Platinum as Indicator Electrode in Manganic Sulphate Solution —Study of the Precipitation Reactions.

MOHD. AJMAL and WAHID U. MALIK, Aligarh.

The ferro-ferricyanide couple, usually employed for carrying out potentiometric titrations between the metal ions and alkali ferrocyanides can be dispensed with, while investigating the Mn (iii) ferrocyanogen complexes. It was found that bright platinum wire dipped in Mn (iii) solution works satisfactorily as an indicator electrode, sharp inflexions being realised both in aqueous and the non-aqueous media. Direct titrations (K_4 $Fecy_6$ in the cell) give two breaks (1 : 1 and 3 : 2 for the ratio Mn^{3+} : $Fecy_6^{4-}$), while the reverse only give one break (1 : 1). Evidence for the formation of the complex Mn^{III} $Fecy_6^{III}$ and the presence of the complex anion $Mn(SO_4)_2^-$ could be obtained on the basis of these titrations.

80. Chelate formation between Beryllium (II) and Sulpho-dichloro Hydroxy-dimethyl Fuchson Dicarboxylic Acid (Trisodium Salt) : Studies in the Composition and Stability.

SURESH C. SRIVASTAVA and ARUN K. DEY, Allahabad.

Sulpho-dichloro hydroxy-dimethyl fuchson di-carboxylic acid (tri-sodium salt) which is commonly known as Chrome Azurol S, has been observed to yield very stable coloured chelates in solution with a number of metal ions. Beryllium (II) also forms a violet coloured chelate with Chrome Azurol S (λ_{max} 540 mμ). The composition and stability of the above chelate have been studied in detail using absorbance as well as electrical conductance measurements.

The composition as determined by (i) the method of continuous variations, (ii) mole ratio method, and (iii) the slope ratio method comes out to be 1 : 1 (Metal : Chelating agent). The colour of the chelate is stable between pH 4·5 and 7·5.

The value of stability (log K), as determined by two methods using absorbance data is $4{\cdot}4 \pm 0{\cdot}1$ and $4{\cdot}7 \pm 0{\cdot}4$ respectively, at temperature 30°C, pH 6·0 and ionic strength 0·1. The free energy change of formation corresponding to the two values of log K has been evaluated to be $-6{\cdot}18 \pm 0{\cdot}2$ and $-6{\cdot}5 \pm 0{\cdot}5$ K Cals. respectively. Suggestions have also been advanced on the possible position of the chelate ring in the complex.

PHYSICAL

81. Kinetics of the Hydrolysis of Polyphosphates—I. Pyrophosphate.

H. C. MALHOTRA and D. V. S. JAIN, Delhi.

The kinetics of the hydrolysis of pyrophosphate has been studied under different conditions of pH (1—7) temperature (50°—75°C) and ionic strength (0·1 to

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1·5). The rate of hydrolysis is found to be first order in pyrophosphate but it is not a simple function of the hydrogen ion concentration. The rate is decreased with the increase of ionic strength. Activation energy and pre-exponential factor for the over-all reaction are also evaluated.

82. Kinetics of the Hydrolysis of Polyphosphate—II. (The role of H+ in the hydrolysis of pyrophosphates).

H. C. MALHOTRA and D. V. S. JAIN, Delhi

The rate of hydrolysis of pyrophosphate has been shown to depend on the pH of the solution. However, the rate is not a simple function of the H+ ion concentration and the H+ ion does not act as a catalyst in the ordinary sense. It has been shown that the rate of hydrolysis depends on the concentrations of $H_4P_2O_7$, $H_3P_2O_7^{-1}$, $H_2P_2O_7^{-2}$, $HP_2O_7^{-3}$, $P_2O_7^{-4}$. From the knowledge of the dissociation constants of $H_4P_2O_7$, the concentration of each species is estimated and the rate constants for the hydrolysis of the individual anions calculated. An estimate of the activation energies of the various reactions in the system has also been made and the data is in complete agreement with the proposed mechanism.

83. Reduction of Eosin at Dropping Mercury Electrode.

N. R. BANNERJEE and B. B. BHATTA, Delhi.

The reduction of eosin has been followed polarographically in aqueous as well as alcoholic solutions at the dropping mercury electrode. Current voltage curves of 10^{-3} to 10^{-4}M solutions were obtained using a Cambridge pen-recording polarograph with a quiet mercury pool as the reference electrode. Between −1·25 and −1·5 volts, the waves showed a well-defined diffusion plateau. The diffusion current was proportional to the concentration of eosin and was dependent on the height of the mercury column. It was found that the reduction of eosin involved only one electron. The following mechanism of the reduction is suggested :

Eosin forms an oxonium ion giving the molecule an orthoquinonoid structure. The oxygen which is the seat of positive charge in the ion, is attacked at the D.M.E. and is reduced. Half wave potential was found to shift to more negative values with increasing pH of the solution till neutrality was reached and it then receded slowly to less negative values as alkalinity increased. At about pH 13, evidence for alkali fission was seen in the C-V curve : two diffusion plateaus were obtained, one due to eosin and the other, to a fission product or products.

84. Strength of Sulphonic acids and their use as titrants in acetic acid and fluorosulphonic acid—Part I.

RAM CHAND PAUL, KAILASH CHANDER MALHOTRA, SARVISIDER SINGH PAHIL and SHAM KUMAR VASISHT, Chandigarh.

Determinnation of equivalent conductivity of fluorosulphonic acid in acetic acid has revealed that it is a strong protonic acid with strength comparable to that of perchloric acid. It has been developed as an acid in this medium by carrying out conductometric, potentiometric and visual titrations using crystal violet and malachite green as internal indicators.

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85. The Chemistry of Protoactinium : II : Paper Electrophoresis in HCl solutions.

C. GOPINATHAN, K. S. VENKATESWARLU and J. SHANKAR, Bombay.

A semi closed type of apparatus has been designed for use in electrophoresis studies of Pa-233 in HCl solutions. These experiments indicated that the protoactinium containing anions to cations ratio increases as HCl concentration is changed from 3·5 to 6·0 M. From log (anion/cation) against log a ±HCl graphs one can postulate the nature of cation to anion conversions involved. The mobility of Pa-233 is greatly enhanced by the presence of traces of fluoride ion, and the histograms indicated the presence of a clear cationic species.

86. X-ray studies of Neutron Irradiated Calcite and Gypsum.

J. M. LUTHRA and J. SHANKAR, Bombay.

Warren and Averbach's method has been used to separate the particle size and strain effects in the case of neutron irradiated calcite and gypsum. It has been observed that calcite shows line broadening while gypsum shows only lattice expansion along the b axis. These differences in behaviour towards radiation have been discussed in the light of their structure and bonding.

87. An Electrochromatographic study of the nature and number of species formed as a consequence of (n, γ) reaction in Sodium Ethylene Diaminetetra-acetato CO (III).

J. SHANKAR, K. S. VENKATESWARLU and R. SHANKER, Bombay.

Paper electrophoresis of neutron irradiated sodium ethylene diamine tetra-acetato CO (III) indicated that besides the parent complex anion and CO++, other neutral and positively charged species are also present. The yield of the various species depends upon the pH of the electrophoresis run. This is true even of thermally annealed samples. The increase in the yield of the parent complex can be explained as due to fast, pH dependent reactions of the degradation products when the irradiated solid is dissolved.

88. Ion Exchange studies in Non-aqueous Solvents.

J. SHANKAR and M. R. GHATE, Bombay.

Ion exchange equilibrium studies between lithium and hydrogen on Amberlite IR-120 and Dower-50, (Sulphonated polystyrene type cation exchangers) have been studied in aqueous, 25% and 50% acetone-water media (by volume). The equilibrium quotients have been determined over the whole range of resin compositions. The difference between the equilibrium quotients in different media has been explained on the assumption that the resin phase activity coefficients do not play an important role under the conditions employed. The activity coefficients of lithium and hydrogen in 25% and 50% acetone-water media at 0·1 M ionic strength have been computed.

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89. Kinetics and Mechanism of Cation Exchange Reactions in presence of complexing agents.

J. SHANKAR and T. R. BHAT, Bombay.

Kinetics of the NH_4+-Cu+^2 and NH_4+-Nd+^3 exchange on cation exchange resin were studied in the presence and in the absence of complexing agent (EDTA) in the concentration range of less than 0·1N. While the total exchange rate increased by the presence of EDTA the rate of attainment of equilibrium was reduced. In the absence of complexing agent the film diffusion of $Cu+^2$ and $Nd+^3$ were found to adversely affect exchange rate whereas in the presence of EDTA the film diffusion of $NH+^4$ was the major rate determining step. Kinetics of the displacement of copper by NdY−, in the presence of NH_4+, was also studied and the different rate controlling steps were discussed.

90. Nature of the species formed on dissolution of Trisacetylacetone CO (III) after (n, γ) reaction in solid state.

J. SHANKAR, MANOHARLAL and K. S. VENKATESWARLU, Bombay.

Paper electrophoresis studies of neutron irradiated tris-acetylacetone CO(III) are described in this communication. Two distinct peaks are observed, which are identified to be due to the parent complex and $CO+^2$. In all cases, including samples diluted with the isomorphous rhodium and aluminium complexes, the parent species moves a little towards the negative side of the histogram indicating a small associated positive charge. Thermal annealing for four hours at 100°C resulted in a perfectly neutral parent species. On dissolution of irradiated tris-acetylacetone CO(III) in acetylacetone, before the chemical separation resulted in an increase in retention. This can be explained as due to the presence of radical deficient positive species.

91. Isotopic Exchange in the Cobaltous-cobaltic system (III) effect of certain Ions.

J. SHANKAR and B. C. DESOUZA, Bombay.

The effect of certain common ions on the exchange rate in this system has been studied. The effect of the sulfate ion has been studied in detail and the $\triangle^{\neq}H$ and $\triangle S^{\neq}$ values were found to be 11·6±2 KCals and −13±7 eu. at ionic strength =2·0. The formation constant for the specie $COSO_4+$ was found to be $16f^{-1}$ at 0°C and ionic strength =2·0, and the $\triangle H$ and $\triangle S$ values were 0·0±1·6 KCals and 1·8±0·6 eu. respectively. The nitrate ion was also found to accelerate the exchange and the formation constant for the specie $(CoNO_3+^2$ was $0·39\pm0·09f^{-1}$ at 0°C and ionic strength=1·0. The fluoride ion showed no effect on the exchange rate in the concentration range of $1·6\times10^{-3}$ to $5·0\times10^{-2}$ NaF (f). Chloride and thiocyanate ions were rapidly oxidized by the cobaltic ions. The Ag+ causes a large increase in reaction rate.

The probable mode of participation of these ions in the exchange mechanism has been discussed.

92. Some theoretical aspects on the retaining bed used in displacement Chromatography in the presence of EDTA.

J. SHANKAR and T. R. BHAT, Bombay.

Some theoretical aspects of the retaining bed used in displacement chromatography in the presence of complexing agents are discussed in detail. A theoretical

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method is given and limiting conditions are arrived at by which it will be possible to predict whether a particular retaining bed will be successful under given experimental conditions, from a knowledge of the physical constants such as, the ion exchange equilibrium constant of the uncomplexed cations and the stability constants of the complexes formed by the cations with the eluant. The predicted elution behaviour of a number divalent and trivalent cations with EDTA as eluant are found to agree with the experimental results.

92. (a) Rheochor of Binary mixtures.

H. G. SILAWAT and W. V. BHAGWAT, Indore.

It has been observed that the Mixture Law is applicable to Rheochor in case of non-associated binary mixtures. Following mixtures were investigoted :—

(a) Methyl ethyl ketone-Toluene.
(b) Benzene-Carbon tetrachloride.
(c) Methyl ethyl ketone-carbon tetrachloride.
(d) Benzene-Chloroform.
(e) Benzene-Acetone.
(f) Methyl ethylketone-Chloroform.
(g) Carbon tetrachloride-Ethyl alcohol, and
(h) Toluene-Ethyl alcohol.

93. Effect of Sesquioxides on the Cation Exchange Capacities of Soil Clays.

T. D. BISWAS and S. P. GAWANDE, New Delhi.

Soil clays contain variable amounts of free sesquioxides removal of which by the hydrosulphite (sodium dithionate) method of Mackenzie (*J. Soil Sci.* **1** : 121-220, 1954) was found to affect their cation exchange capacities in case of clay fractions separated from the soils in a catenary sequence which consists of soils ranging from the well drained acidic soils to alkaline soils formed under impeded drainage conditions. The clay fractions of the well drained soils contained illite as the dominant clay mineral with traces of kaolinite and vermiculite whereas in the clays from impeded drained soils, montmorillonite was the dominant clay mineral. The former clays contain about 6 to 10 per cent of free ferric oxide whereas the latter contain about 4 per cent. Free alumina is practical uniform.

In the case of clays from the well drained acidic soils, the cation exchange capacity increased on the removal of free sesquioxides, by about 30 to 40 per cent as compared to the original clay whereas in the case of clays from poorly drained soils, cation exchange capacities decreased by about 10 per cent as compared to the original untreated clay. In the former case, it appears that the free ferric oxide might have blocked the active spots of ion exchange in the absence of which some more spots are available for exchange or else the dilute hydrochloric acid treatment in the process of removal of free oxides might have removed the interlayer aluminium of the clay mineral, thus causing significant increase in cation exchange capacity of the clays. In the latter case, the treatment must have attacked the clay lattice, thereby decreasing the cation exchange capacity.

94. Catalytic Decomposition of H_2O_2 by Kohlschüter's Silver Sol.

VIRENDRA SINGH and S. P. MUSHRAN, Allahabad.

Catalytic activity of Kohlschütter's silver sol has been investigated towards the decomposition of aqueous hydrogen peroxide. The rate of decomposition of

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hydrogen peroxide was followed by titrating the undecomposed hydrogen peroxide with a standard solution of potassium permanganate in presence of H_2SO_4. It has been observed that order of decomposition changes with the concentration of hydrogen peroxide and tends to decrease with the increasing concentration of hydrogen peroxide. Percentage decomposition has also been found to decrease with the increasing concentration of H_2O_2.

The temperature coefficient and energy of activation have been calculated. The energy of activation is low as for all catalysed reactions than uncatalysed one.

The experimental results are explained on Haber-Weiss mechanism for decomposition of hydrogen peroxide.

95. An Ionic Model for Gaseous metallic diatomic oxides to calculate electronic free energy functions.

M. S. CHANDRASEKHARAIAH, Dharwar.

A simple ionic model for gaseous metallic monoxides is proposed. Using this model, electronic free energy functions for these gaseous oxides are calculated. In calculating rotational and vibrational partition functions, available spectroscopic data are used and whenever such data are not available, estimated values are used. Method of estimating the rotational and vibrational constants are described. Tabulation of the total free energy functions for MO (g) is presented.

96. Faradaic Admittance and Absorption—A diffusion model.

S. K. RANGARAJAN and K. S. G. DOSS, Karaikudi.

When diffusion alone is the mode of mass transfer, expression have been derived previously for the elements of the faradaic admittance which predict that its phase angle cannot exceed $\pi/4$. Several systems show the possibility of the phase angle being greater than $\pi/4$. Laitinen and Randles had suggested that such anomalous behaviour can be explained by taking into account the correction for the contribution of the adsorbed reactants. A different model, based on diffusion, is presented in this paper and shows how the conclusions of Laitinen and Randles (e.g., the elements of the equivalent circuit, R_a and C_a, are independent of frequency) can be obtained through this model too. A detailed comparison between the parameters used in the two different models are made. Results for a generalised diffusion model are cited.

97. Anodic Polarisation studies on formation and breakdown of Oxide Films in aqueous solutions. Part I: NaOH-NaCl system.

K. S. RAJAGOPALAN, (Miss) K. VENU and K. BALAKRISHNAN, Karaikudi.

The conditions under which protective oxide film formation or passivation will take place in solutions containing different amounts of corrosive (NaCl) and inhibitive (NaOH) constituents are of intetrest from the practical point of view e.g., protection to reinforcements by concrete. An elegant method of studying oxide film formation is the measurement of changes in potentials following the application of a fixed current density. The appropriate current density for studying the above system, differences in anodic polarisation behaviour of corrosive and inhibitive systems, the ratios at which the two constituents should be present for passivation to take place are considered in this paper.

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98. Anodic Polarisation studies on formation and breakdown of Oxide Films in aqueous Solution. Part II : K_2CrO_4-NaCl system.

K. S. RAJAGOPALAN and (MISS) K. VENU, Karaikudi.

Potassium chromate is very commonly used as a corrosion inhibitor in neutral solutions. But the behaviour of chromate ions becomes unpredictable if chloride ions are also present in the system. It is shown that the relative concentrations in which the two types of ions should be present in solution can be correctly predicated by anodic polarisation measurements at a current density which is the characteristic of the system.

99. Anodic Polarisation studies on formation and breakdown of Oxide Films in aqueous solutions. Part III : Sodium Benzoate-NaCl system.

K. S. RAJAGOPALAN and (MISS) K. VENU, Karaikudi.

Sodium benzoate has been shown to be a corrosion inhibitor in neutral solutions. It is not an oxidising agent like chromate. It is of interest to examine at what concentrations of sodium chloride, sodium benzoate can give protection to steel. The appropriate ratios of benzoate and chloride have been determined by the method described earlier. These ratios are discussed in relation to similar ratios for hydroxyl and chloride, and chromate and chloride.

100. Viscosity of Barium Bromide in Dioxane-water Mixtures at 35°C.

P. B. DAS and D. PATNAIK, Cuttack.

The measurements of viscosity of barium bromide in dioxane-water mixtures have been carried out for verifying the modified form of the Jones-Dole equation. (Curr. Sci. 1956, **25**, 337). The concentration of the electrolyte varied from 0·001 to 0·100 M and the solvent composition from 10% of dioxane to 30% of dioxane content by weight. The Jones-Dole equation is found to be inadequate and the experimental data fit in well with the modified equation. The value of 'B' has been found as before to be dependent on the solvent composition.

101. Determination of diffusion coefficient of ferric ions in supporting electrolyte.

H. P. AGARWAL and (MISS) U. RAUT, Bhopal.

In the present work the rate of diffusion of ferric ion in 1-N sulphuric acid was studied using a fritted glass diaphragm cell. In one arm of the cell, solution of known concentration of ferric ammonium sulphate in 1-N sulphuric acid was taken and the amount diffused in another arm of the cell containing the supportig electrolyte (1-N H_2SO_4) was studied by the electro-chemical method. To avoid concentration gradient, the ferric solution in the first arm of the cell was stirred using a mechanical stirrer. The diffusion coefficient of ferric ion at a concentration of ·002 M and ·005 M in 1-N sulphuric acid is $\cdot 512 \times 10^{-6}$ cm.^{2} sec.$^{-1}$ and $\cdot 338 \times 10^{-6}$ cm^2 sec^{-1} respectively at a temperature of 20°C. The method can be extended for determination of diffusion coefficients of other ions in different supporting electrolytes.

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102. A search for seat of Negative Joshi Effect.

B. M. JAISWAL and A. R. SIDDHANTY, Indore.

Theories for negative Joshi effect, $\triangle i$, ascribe it to 1. Volume origin or 2. Electrode surface origin. Studies have been made in Geissler tubes, but there i could not be detected. When one glass electrode was provided by wrapping a copper wire sleeve on the glass wall, $\triangle i$ was detected in the same tube. This shows that the seat of $\triangle i$ is in the glass electrode surface.

103. High Serial Impedance—A condition favourable for occurrence of positive Joshi Effect.

B. M. JAISWAL, Indore.

Studies of potential variation of Joshi Effect have been carried out in an ozoniser containing sulphur vapour. It is found that when LC (Negligible resistance) is ued in series with the ozoniser, positive Joshi effect could not be detected in spite of efforts. When the LC is replaced by pure ohmic resistances of the order of a few thousand ohms, in the same tube under same conditions, positive Joshi effect was detected. It increased with increase in serial resistance. This observation points out that high serial impedance constitutes a condition favourable for occurrence of positive Joshi effect. The cause appears to be the lessening of the effective applied potential on the ozoniser due to the distribution of total applied potential between (1) Ozoniser and (2) Serial resistance.

When serial resistances are very high, no current flows in dark or in light, at lower applied potentials and so positive effect is absent. At higher applied potentials, negative effect is observed. These observations are also discussed in light of the above views.

104. Evidence of Le Chatilier's Principle Holding in Electrical Discharges in gases.

B. M. JAISWAL, Indore.

When electrical discharge is taking place in a gas, there exists a sort of equilibrium between the neutral molecules and/or atoms and ions and electrons, depending upon the value of the applied potential. The threshold potential Vm, has a special significance of being lowest potential at which this equilibrium can exist.

The studies reported, have been carried out in Geissler tubes of same dimensions. (1) It is found that Vm increases with increase in pressure of the gas. (2) At constant applied potential, the discharge current decreases with increase of gas pressure. (3) The discharge current increases by flooding the Geissler tube with photons. All these observations are in conformity with Le Chatelier's principle and therefore point out that it holds in electrical discharges in gases.

105. Conductivity of Potassium Chloride, Sodium Chloride and Sodium Bromide in Methanol-water Mixture at 35°C.

B. PANDA, P. B. DAS and B. NAYAK, Cuttack.

Conductance of potassium chloride, sodium chloride and sodium bromide in methanol-water (74 : 24 w/w) have been measured at 35°C. The equivalent conductance at zero concentration and the dissociation constants have been determined

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by using the methods of Fuoss & Kraus and that of Shedlovsky. The values obtained by the two methods are in good agreement. The diameter of the ion pairs have also been calculated, employing Bjerrum's and Stoke's methods.

106. Studies in Membrane permeability Activation Energy of diffusion of various electrolytes through Chromic ferro and ferricyanides.

FASIH A. SIDDIQUI and WAHID U. MALIK, Aligarh.

To elucidate the factors responsible or the differential rates of permeation of various ions through inorganic membrane, the permeability of various electrolytes through chromic ferro and ferricyanides at different temperatures were determined.

The order of permeability of potassium salts was KCl > KNO_3 > K_2SO_4 and for sodium salts NaCl > $NaNO_3$ > Na_2SO_4 for both chromic ferro and ferricyanide membranes. The ratio of Cl'/SO''_4=was 2·2 showing thereby that the valency factor is also responsible for the permeability of various electrolytes. The energy of activation was determined for various electrolytes by plotting log $(p \times 10^2)$ against $1/T \times 10^3$. It was found that the values were greater than for the free diffusion, confirming thereby that the membrane barrier is mainly electrostatic and the energy barrier which the ions have to surmount in passing through the membrane must be greater than for the free diffusion.

107. Polarography of Heavy metal Soaps—Behaviour of Nickel palmitate and Myristate at the Dropping Mercury electrode in non-aqueous media.

RIZWANUL HAQUE and WAHID U. MALIK, Aligarh.

Polarographic studies of the pyridine complexes of Nickel palmitate and myristate were carried out in non-aqueous media using (1) Lithium chloride in 50% benezene methanol mixture, (2) Methyl hydrogen sulphate in 50% benzene methanol mixture and (3) Potassium chloride in ethylene glycol. It was found that both the complexes are reduced reversibly at the dropping mercury electrode and the reduction takes place with one electron transfer. The wave height was found to be dependent upon the concentration of the soap solution, the values of i_d being directly proportional to the concentration of the metal ion. From the studies it was concluded that the polarographic method can be employed for the estimation of the metal ion in these soaps.

108. Spectrophotometric and Conductometric investigations on Cu(i)-di sodium 1:8 dihydroxy naphthalene 3:6 disulphonate (Chromotropic salt) Chelate.

S. M. FAZLUR REHMAN and ANEES UDDIN MALIK, Aligarh.

The chromotropic acid (sodium salt) has been found to form with cuprous ions a pink coloured chelate. The nature and the composition of the chelate has been investigated by spectrophotometric and conductometric methods. The chelate has the composition Cu_2 (DNS) and λ_{max} lies at 430 mμ. It is stable between pH 5·0 and pH 7·0. The values of formation constant K and $\triangle F^\circ$ are $2{\cdot}1 \times 10^4$ and $-2{\cdot}58$ K Cals at 30°C respectively.

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109. Study of the reaction between Potassium Ferrocyanide and Nitrobenzene with and without the presence of Cr+++.

G. P. SHARMAKAPHLEY and WAHID U. MALIK, Aligarh.

Experiments on the interaction of chromic chloride and potasium ferrocyanide have provided enough evidence for the decomposition of potassium ferrocyanide to potassium ferro-aqua-penta-cyanide.

$$K_4 Fecy_6 \overset{H_2O}{\underset{H_2O}{\rightleftharpoons}} K_3 Fecy_5 H_2O$$

Preliminary experiment of the Kinetics of decomposition were carried out by absorption studies by obtaining the nitroso-benzene complex (violet in colour).

It was found that the presence of Cr ions in very small quantities (10^{-4}M) is sufficient to develop the violet colour, whose intensity increases with the lapse of time. The reaction was found to be dependent on the concentration of Cr+++ ions up to a certain concentration, the O.D. values remaining almost constant after reaching a certain maximum values. The reaction was also found to be dependent upon the concentration of nitroso-benzene. Exposure to ultra-violet light helps in attaining the equilibrium quickly.

110. Intrinsic Viscosity Temperature Studies of Potato Amylose Acetate.

R. D. PATEL and R. S. PATEL, Gujarat.

The viscosity of the three fractions of amylose acetate of potato starch is studied in chloroform and a mixture of chloroform and cyclohexane at different temperatures. From the results, the parameter K have been determined at 32°C, 40°C and 48°C. By using these values of K, the thermodynamic parameters have been calculated.

111. The calculation of activation energy of self-diffusion in some solid metals.

RAM GOPAL, Lucknow.

A simple method for estimating the activation energy of self-diffusion Q in some solid metals, based on Pauling's concept of localised atomic orbitals in metals, is proposed. The values of Q calculated for different metals appear to be in general agreement with the available experimental data. The method developed avoids the tedious quantum-mechanical calculations and it is believed that the procedure outlined will be of general applicability.

A method for estimating the total binding energy, or lattice energy has been described. It is an extension of the method used for simple metallic system like alkali and alkaline earth metals. The method uses the Pauling's metallic valency in place of ordinary chemical valency of metals. It has been pointed out that the values of lattice energy of transition metals estimated by Ketelaar, Mott and Jones and obtained from Wilson's equation, do not conform to the physical properties of these metals and appear to be too low.

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112. Relation between the lattice energy and melting point in some heavier metals.

RAM GOPAL and MOHD. MUKHTAR HUSSAIN, Lucknow.

The lattice energies ($-U_0$) of metals given by $-U_0 = I \times n + S$ (where I is the ionization potential, 'n' the Pauling's metallic valency and S the latent heat of sublimation of tht metal concerned) appear to be in better correspondence with the high of the metal concerned) appear to be in better correspondence with the high melting points of transitional metals as compared to the values of $-U_0$, estimated earlier using ordinary chemical valency (i.e. the number of electrons in the valency shell) of the metals (cf. Ketelaar, Wilson, Mott and Jones. The relationship $-U_0/T_m$ has been found to be approximately constant for similar metals (in fact it is around 0·5 for many of them) and it has been shown that this ratio, calculated from the knowledge of the respective heats of fusion and specific electrical conductivities in solid and liquid states respectively, is in good agreement with those calculated directly from $-U_0$ and T_m.

A detailed comparision of the different physical properties, besides the melting points, of such metals with their respective lattice energies is under way.

113. "Studies on solutions of high dielectric canstant" partial molal volume of some uni-univalent electrolytes in formamide at 35°C.

RAM GOPAL and R. K. SRIVASTAVA, Lucknow.

In continuation with the work reported earlier (Proc. Ind. Science congress part III, 1961) on partial molal volume of uni-univalent electrolytes in formamide, attempts have been made to refine the experimental techniques to get more accurate and reliable data, before extending the study to the other systems. Pyknometers reading up to 0·0005 c.c. have been employed in the present investigation and weighings have been performed in dry atmosphere. The values of partial molal volumes ($\bar{V}o$) for KCl, KBr, KI, KNO_3, $NaNO_3$, NH_4NO_3, and NH_4Cl are 32·20, 38·15, 50·05, 43·5, 33·90, 49·55, 37·00, which are slightly higher than those reported previously*. Further, these are slightly (but definitely) higher than the corresponding values in water.

Ammonium salts show the least deviation.

114. Potentiometric study of copper (II) Triethanolamine complexes.

S. MAHAPATRA and R. S. SUBRAHMANYA, Bangalore.

A study of the nature of complexes produced in copper (II)—triethanolamine system has been made by potentiometric methods. It was found that $\bar{n}$ vs p [A] curves obtained with various concentrations of cupric ion and triethanolammonium ion titrated with sodium hydroxide did not coincide indicating polynuclear complex formation. It was also noticed that $\bar{n}$ vs p [A] curves obtained at various pH values for the same metal ion concentration also did not coincide indicating that complexes containing both triethanolamine and hydroxy groups are produced. However, when the titrations are conducted by Bjerrum technique in presence of 1·0 M triethanolammonium ion, the $\bar{n}$ vs p [A] curves coincided even at fairly high concentrations of cupric ion indicating that only mononuclear complexes are produced. The successive formation constants of MA and MA_2 as obtained from $\bar{n}$ vs p [A] curves are $10^{4.5}$ and $10^{2.6}$ respectively.

* With S. B. Misra who has discontinued.

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115. Studies on the Hydrolysis of Cupric ion.

S. MAHAPATRA and R. S. SUBRAHMANYA, Bangalore.

A study of the hydrolysis of cupric ion has been made employing various concentrations of cupric ion (10, 6, 2, 1·0, 0·5, 0·25 mM.). It is noticed that $\bar{n}$ vs p[OH] curves depend upon the concentration of potassium nitrate used to keep the ionic strength of the medium constant. The $\bar{n}$ vs p[OH] curves for various concentrations of metal ion did not coincide indicating polynuclear complex formation. Applying Sillen's 'core+links' theory it was possible to find out that $Cu_2(OH)_2{}^{++}$ is the most probable species present in the system. It has also been possible to get an ideal mononuclear curve from the experimental $\bar{n}$ vs p(OH) curves by applying limiting techniques. The constants obtained from the mononuclear curve for $CuOH^+$ and $Cu(OH)_2$ are $10^{5.8}$ and $10^{12.8}$ respectively. The results obtained indicate that $Cu(OH)^+$ and $Cu(OH)_2$ will immediately get converted to $Cu_2(OH)_2{}^{++}$ according to the following scheme.

$$Cu(OH)_2 \rightleftharpoons Cu(OH)^+ + OH^-$$
$$2Cu(OH)^+ \rightleftharpoons Cu_2(OH)_2{}^{2+}$$

116. Studies on the coagulation of antimony and gold sols by light extinction and surface leaving techniques.

ARVIND KUMAR, AMAL K. BHATTACHARYA, and
ABANI K. BHATTACHARYA, Agra.

Antimony and Gold sols were prepared and their precipitation values were studied by KCl, $BaCl_2$ and $AlCl_3$ by employing the light extinction and the surface leaving methods in the light of the equation $C = a + \frac{m.\ 1/t.}{n + 1/t.}$. Different concentrations of these electrolytes were added to the sol and the corresponding times of coagulation were determined by light extinction and visual surface leaving method. The times of coagulation by both the methods could not be expected to be indentical, because the stage of coagulation may not be the same, when different techniques are employed. The merit of this equation, however, was not affected, inasmuch as the relation between $1/C-a$ of electrolyte and their respective times of coagulation was found to be linear. The constants a, m, and n were determined for each electrolyte.

117. Studies in the adsorption of Hydrogen on Iron-kieselguhr powder.

C. S. SWAMY and M. R. A. RAO, Bangalore.

The adsorption of hydrogen has been studied in the temperature range of −191 to 350°C on a variety of Iron kieselguhr samples prepared by the method of impregnation. At −191°C, the hydrogen is mostly physically adsorbed both on the support and on the metal. With increase in temperature, the adsorption decreases up to 0°C. With increase in temperature, the adsorption goes on increasing up to the highest temperature studied (350°C) indicating activated adsorption of hydrogen. A maximum in the absorption isobar is, however, noticed near about 275°C.

The adsorption isotherms at temperatures of 97°C and above show a peculiar pressure dependence in that the isotherms become convex to the pressure axis above a pressure of 40 cm. Hg. This has been explained on the basis of the migration of adsorbed hydrogen atoms. This has been further confirmed by the

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fact that readsorption studies of hydrogen employing a Topler pump showed that the sum of the retention and readsorption at any particular temperature exceeds the original adsorption.

118. Studies on the formation of surface complexes of Hydrogen and Carbon Monoxide on Metallic iron.

K. S. NARAYAN and M. R. A. RAO, Bangalore-12.

The effect of small quantities of presorbed carbon monoxide on the subsequent adsorption of hydrogen has been studied in the temperature range of 97°C to 250°C. It has been found that at 97°C and 134°C the adsorption of hydrogen is not affected by the presence of even 1·5 c.c. of presorbed carbon monoxide. At 200°C and 250°C, on the other hand, the adsorption of hydrogen is enhanced by the presence of presorbed carbon monoxide. The enhancement of hydrogen adsorption increases with increasing quantities of presorbed carbon monoxide and also the enhancement is greater at elevated pressures. These results have been explained on the basis of the formation of surface complexes of hydrogen and carbon monoxide of varying composition ($CO : H_2$ and $CO : 2H_2$), the higher hydrogen complex being formed at 200°C and 250°C.

119. Solvent Effects on $n \rightarrow \pi^*$ Transitions:—Evaluation of the various types of solute-solvent interactions.

A. BALASUBRAMANIAN and C. N. R. RAO, Bangalore 12.

Effect of various non-polar, polar and hydroxylic solvents on $n \rightarrow \pi^*$ transitions have been studied in detail. The relative magnitudes of the contribution due to the refractive index term, dielectric constant term and hydrogen bonding have been evaluated. Hydrogen bond energies of different base—alcohol systems have been estimated. Evidence is presented for the equilibrium of the hydrogen-bonded species with the free species.

120. Mechanism of Crystal Structure Transformations : Studies on the Anatase-Rutile Transformation.

S. R. YOGANARASIMHAN and C. N. R. RAO, Bangalore 12.

Variations of crystallite site, particle size, surface area and lattice dimensions accompanying the crystal structure transformation of anatase have been studied. The anatase lattice expands prior to the transformation. While surface area has negligible effect on the transformation, particle site is an important parameter. Impurities affect the transformation markedly. These studies throw light on the detailed mechanism of this crystal structure transformation.

121. Alkali Complex Ions.

S. K. K. JATKAR and Mrs. VIJAYA A. DEO, Poona.

The authors have calculated stability constants of the complex ions $M(H_2O)_4L_4^{3-}$ for alkali salts. Straightline graphs are obtained by plotting log Kc versus $(-\log f)$ with higher values of slope, which can be obtained in theoretical value by adjusting the various parameters such as dielectric constant, distance of closest approach and water of hydration, etc.

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122. Viscometric studies on 'Akli' bentonite suspensions—variation in viscosity with pH in presence of some anions.

J. P. SINGHAL and W. U. MALIK, Aligarh.

The influence of a number of anions on the viscosity of a dilute suspension of 'Akli' bentonite was studied. The results reveal not only a great tendency of the clay to undergo gelation but the existence of a definite lyotropic series in bringing about solvation. Experiments performed on the variations in viscosity with pH for bentonite suspensions containing a fixed amount of the anions show that the maxima and minima in the pH—viscosity curves appear at more or less the same pH (maxima pH $\approx$10; minima pH $\approx$ 11). However, the absolute values of the viscosity differ from electrolyte to electrolyte. Here again the existence of a lyotropic series is found, the order being,

$$\text{Citrate} > SO_4 > ClO_3 > CNS > NO_3 > Cl$$

It has been visualised that the latter behaviour can be employed in characterising clay minerals.

123. Infrared and Raman Spectra of Polyatomic molecules and Dipole moments.

S. K. K. JATKAR and N. C. GUJERATHI, Poona-7.

The theories of infrared and Raman spectra of polyatomic molecules are based on the various fundamental modes of longitudinal and bending vibrations. The excess of lines in the spectra over 3n-6 are usually explained on the basis of harmonics and combinations of the fundamental frequencies, although there is no satisfactory agreement between the calculated and observed values. In the present paper the authors have shown that the spectra originate from dipolar bonds and their inductive contributions on each other by the component law postulated by Jatkar.

A study of the main spectra of water in vapour, liquid and ice, shows that there are two types of molecules with 104°.30′ and 109°28′ as $\overset{\wedge}{HOH}$ angles. The study of the spectra of hydrogen peroxide shows that the nature of the OH bond and the inductive contributions is also given by component law. The various dipole moments of the bonds show a straightline relationship with the infrared and Raman frequencies.

124. Electrophoretic velocity by the boundary method and measurement of the internal variations of potential or current by electronic technique.

P. D. BHATNAGAR, Agra.

The paper deals with the introduction of electronic systems in the electrophoretic determinations by the boundary method. Constant voltage and constant current supplies based on electronic circuits have been described as against those based on mechanical means as used by the previous workers in this field. A new and more accurate system of measuring changing voltages developed by combining the merits of a potentiometer and a vacuum tube voltmeter has also been described. It has been pointed out on theoretical grounds that the electrophoretic studies under constant current conditions will be more cogent for heterogeneous systems like colloids under study.

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125. Transference number of the phosphoric and nitric acid by moving boundary method.

R. D. SRIVASTAVA and K. BANERJEE, Lucknow.

The transference numbers of nitric and phosphoric acids have been determined before by several methods at 25°C and 20°C only. We have determined these values at 50°C and 40°C and in several concentrations. We have also studied the effect of the variation of the concentration of solutions on the transference numbers in these acids. Our method of approach towards the problem was similar to Kerker, and coworkers (Trans. Faraday Soc. *56*,1039, 1960 and *57*, 781, 1961). Each set was repeated at least three to four times till constant result is obtained.

From the data obtained limiting transference number was evaluated by extrapolation and the values of calculated. The results were in conformity with the values of limiting equivalence cited in the literature. It was also noticed that the transference numbers decrease with the rise of temperature and that its value changes with the change in concentration of the solution and attains constancy near the value which is predicted by Kohlrausch's regulating function. At higher concentration it was noticed that the moving boundary method fails to give consistent result, which supports the observation made by Kerker.

126. Studies on the system, $CuSo_4$-$(NH_4)_2SO_4$-H_2O Cupric Sulphato complexes.

P. R. KRISHNAN and A. C. CHATTERJI, Lucknow.

The above system was investigated over a wide range of concentration spectrphotometrically both in the visible as well as in the ultraviolet region. Complex-ion formation between $CuSO_4$ and $(NH_4)_2SO_4$ at ratios 1 :1, 1 :2, 1 :3, 1 :5 and 1 :6 was indicated. The Bathochromic shifts in the visible region point to the interaction of the ligand field. With the weak d-d transitions on the Cu++ ion. Whereas, if an ion pair of the type $(Mx(H_2O)I_4)$ were involved, the ligand would be too far away from the metal ion to affect its visible spectra. The fact that the same five maxima were evident at five distinct wave-lengths in the u.v. region conclusively rules out the existence of polynuclear complexes. The u.v. spectra have been interpreted in terms of charge transfer spectra, the electron from SO_4 reduces Cu++ to Cu+.

A potentiometric study of the above system, using copper and gum electrodes confirmed complex-ion-formation at the above ratios. The stability constants as well as the thermodynamic constant for the complex ions, were determined.

127. Physical Studies of Proteins. Part I—Potentiometric determination of the Binding of chloride ion with gelatin.

SALAHUDDIN and WAHIDA MALIK, Aligarh.

The binding of the chloride ions with gelatin, studied potentiometrically by titrating against aluminium chloride and hydrochloric acid revealed the following interesting informations.

The chloride ion binding although small is appreciably influenced by pH. In the case of aluminium chloride, the chloride ion bound increases on decreasing the pH from 4·24 to 2·4, whereas a similar behaviour is observed in the case of hydrochloride acid for pH change from 11·32 to 10·00. These results suggest that

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the binding is dependent both upon the initial concentration of the chloride ion as well as the pH. At lower pH values the number of positive nitrogen in the protein-structure increases due to the reaction

$$-NH_2 + H+ = -NH_3+$$

thereby increasing the uptake of chloride ion by gelatin.

128. Polarographic study of complex formation between Fe (II) and thiomalic acid.

(Km.) UMA KAPOOR and H. L. NIGAM, Allahabad.

Polarographic study of the reaction between Fe(II) and thiomalic acid (TMA) has been made in borax buffer (pH 9), phosphate buffer (pH 7) and acetate buffer (pH 5).

The observations on anodic and cathodic currents indicate a 1 : 1 complex formation between Fe(II) and thiomalic acid.

129. A study of kinetics of bromination of cinnamic acid and its derivatives (Part II) in different solvents.

A. N. BOSE and V. K. SETH, Lucknow.

The bromination of cinnamic acid and its derivatives were studied in different solvents as carbon tetrachloride, benzene, nitrobenzene and methyl alcohol. The rate of reaction at different temperatures and energy of activation were calculated. With the help of these the values of other thermodynamic constant were calculated. In the case of cinnamic acid the rate of reaction in different solvents were found to be of following order. Methyl alcohol > Nitrobenzene > Carbon tetrachloride > Benzene. In the case of p- isopropyl cinnamic acid the order of rate of reaction in these solvents were different. It was of the form Methyl alcohol > Nitrobenzene > Benzene > Carbon tetrachloride. No definite reason, as yet, can be attributed to the change in the rate of reaction studied in different solvents.

It was not possible to derive any order for the solvents in the case of p- methyl cinnamic acid, as solutions of this acid could not be prepared of the concentration, at which rate of reaction of other acids have been determined.

Frequently factor (PZ), entropy of activation (S*) and free energy of activation (F*) were found to be changing with the change in solvents. These factors directly affect the rate of reaction. When methyl alcohol was used as a solvent for all the compounds, these factors were found to be more or less constant throughout the series.

130. Relative stabilities of certain metal pyridine thiocyanate complexes.

G. S. RAO and A. D. DAMODARAN, Bombay.

The thermodynamic properties $\triangle$ F, $\triangle$ H and $\triangle$ S have been calculated for the pyridine thiocynate complexes of cobalt, nickel, zinc and copper from their dissociation pressures. The relative stabilities of these complexes have been discussed in the light of the above data and found to be in the order Co > Ni > Zn > Cu.

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131. Solvent Effect on Lifetimes of fluorescent Compounds.

MISS K. K. ROHATGI, Calcutta.

Absorption spectra of fluorescein ($1\,000\times10^{-4}$ M) in alkaline media have been studied in a number of 90% v/v hydroxylated solvents such as water, series of primary alcohols and glycerol. ν_{max} is found to exhibit a blue shift with increasing dielectric constant (ε) of the solvent. From the area under the absorption curve, the natural radiative life-time (τ_N) of the fluorescent anion has been calculated. Then this is compared with the values of av. life (τ_{av}), as obtained from phase-shift method, it is observed that while τ_N decreases in the order EtOH, n-PrOH, n-BuOH and glycerol, a reverse order of variation is obtained for τ_{av}.

This difference $\Delta\tau = \tau_N - \tau_{av}$ has been explained as due to increasing overlap between absorption and emission spectra caused by stabilisation of ground and excited state energy levels of the absorbing dipole by the solvent orientation polarisation effect on Onsager's reaction field, to difftrent extent in different solvents. Hence $\Delta\tau$ should be proportional to $(\nu_A - \nu_F)$ where ν_A and ν_F are frequencies of absorption and emission maxima respectively. Following the treatment of Lippert and of Mataga et al, $\Delta\tau$ is plotted against $\left(\frac{D-1}{2D+1} - \frac{n^2-1}{2n^2+1}\right)$. All the points except that for water, fall on a line. From the negative slope it is concluded that fluorescein anion is less polarisable in the excited state than in the ground state.

132. 'The Kinetics of the Reaction between Copper and Iodine Solution in non-aqueous medium'.

P. S. MENE, K. A. VENKATACHALAM and T. DAS, Nagpur.

The reaction between Copper and Iodine solution in non-aqueous medium (Methanol) has been studied and the following points have been observed :— (1) The reaction is of the first order with respect to the Iodine present in the solution, (2) The formation of Cuprous iodide film as a result of the reaction and its unaffecting nature in the rate of reaction, (3) Although a standard rate of 100 r.p.m. for the stirrer is recommended to give reproducible results, consistent results have been obtained with a rate of stirring as high as 200 r.p.m., (4) The nature of the surface of the metal has been found to have little effect on the reaction, (5) The graph of Iodine absorption versus time in non-aqueous (Methanol) medium is found to agree well with those of previous workers, who studied similar systems.

133. Hammett acidity function (H_0) in aqueous acetone.

M. M. MISRA and B. NAYAK, Cuttack.

The Hammett acidity function (H_0) of the solutions of three strong acids, namely, perchloric, hydrochloric, and sulphuric acid, have been measured in acetone-water mixtures, containing 10 and 20 weight % of acetone and perchloric acid alone in acetone-water containing 30 weight % of acetone using p-nitroaniline, and o-nitroaniline as indicators. The concentration range covered for each of these acids is up to 2M. The general validity of H_0 concept in these acetone-water solvents has been established. The effects of the addition of neutral salt on H_0 of 0·25M hydrochloric acid have been examined in solvents containing 10 and 20 weight % acetone. The results appear to be similar to those obtained with aqueous solutions and indicate the specific nature of salt effects.

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134. Base Strengths of Nitroanilines in Mixed Solvents : pK's of *Ortho and Meta* Nitroanilinium Ions in Aqueous Acetone.

M. M. MISRA and B. NAYAK, Cuttack.

The pK's of *ortho and para* nitroanilines have been determined in acetone-water mixtures containing varying proportion of acetone up to 30 weight per cent. The pK's were found to decrease with the increase of the acetone content of the medium. This has been explained qualitatively from the stand point of the changes, likely to occur in the activity coefficients of various species in solution with the addition of the organic solvent.

135. Effect of the nature and concentration of the supporting electrolyte on the half-wave potential and diffusion current.

S. N. MUKHERJEE and MRS. ANIMA CHAKRAVARTY, Calcutta.

The diffusion current and half-wave potentials were measured at different concentrations of Ni (ous) and Co (ous) ions in presence of different concentrations of the supporting electrolytes : KCl, KNO_3, NH_4Cl, and $CaCl_2$. Both these parameters exhibit variations which could not be accounted for by changes in viscosity alone. An attempt has been made to explain the observations in the light of the influence of (1) ionic strength, (2) inter ionic forces and (3) the hydrogen overvoltage.

136. The use of oxycellulose-collodion film membrane-electrode for the determination of cationic activity.

H. J. CHAINANI and C. S. NARWANI, Bombay.

A single sheet oxy-cellulose-collodion film of various thickness (0·0205—0·065 cm.), containing 94 m.eq. of $-COOH$ per 100 gm.s. and inactive collodion as a binder, clamped between rubber washers at one end of a glass tube (dia : 1 cm.) could be used as a membrane electrode for determining the activity of a given aqueous solution of an acid or a salt, the saturated calomel electrodes being dipped in the two compartments, the tube and the beaker. Before using, the membrane was soaked for two hours in the solutions of the electrolyte to be studied by introducing 0·0015N solution inside the tube and 0·1N in the beaker. The membrane potential reached equilibrium within five minutes and was constant for more than half an hour. The activity of the cation was calculated by using the equation

$$E = (2t_+ - 1)\ \frac{RT}{F} \log_e \frac{a_2}{a_1}\ ;$$

t_+, the transport number inside the membrane was determined from the slope of the st. line graph obtained by plotting E against $\frac{RT}{F}\log_e \frac{a_2}{a_1}$ for different values of $\frac{a_2}{a_1}$. The error in the observed activity was ± 3% in case of salts, and in the pH ± 0·01 in case acids.

137. Polarographic study of metal ion complexes of Keratin fibres (Wool) : Part I, Nitrates and chlorides of Hg++ and Cd.++.

MISS V. T. BALWANI and C. S. NARWANI, Bombay.

Reactions of $Hg(NO_3)_2$, $HgCl_2$, $Cd(NO_3)_2$ and $CdCl_2$ respectively at different concentrations, and room temperature, with (i) pure wool, (ii) Formaldehyde-

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treated, (iii) Benzoquinone-treated, have been studied by determining Polarographically the concentrations of the (i) Equilibrium solutions, (ii) the HCl extracts and (iii) the NaCl extracts. From the difference in diffusion currents, the gm-atoms of the metal combined with one gram-molecule of wool, have been determined in each case. It has been observed that nitrates of Hg and Cd react with -SH, -COOH and -S-S groups and chlorides of Hg and Cd with -COOH, -S-S and and $-NH_2$ in case of pure wool. It has been presumed that Hg++ ions combined with -COOH groups through electrovalent bond, is replaced by Na+ ions on extraction with NaCl, and that it combined with -S-S- to form -S-Hg-S- and $-NH_2$ to form -NH-HgCl. In case of Formaldehyde-treated wool only -COOH and -S-S-groups and in the Benzoquinone treated only -COOH groups are free for reaction with Hg++ and Cd++. It has been also observed that the time for completion in 0·07 M $Hg(NO_3)_2$ and $Cd(NO_3)_2$ in 4 and 4½ hours respectively for one gm. molecule of wool.

Thus the number of -COOH, -S-S- and $-NH_2$ groups in one molecule of wool have been calculated to be 40, 56 and 50 respectively.

138. Polarographic behaviour of Nickel-tetrametaphosphate complexes.

C. S. RAMANATHAN and R. S. SUBRAHMANYA, Bangalore.

The polarographic behaviour of the complexes formed by nickel with tetrametaphosphate has been investigated. The effect of pH and the influence of competing ligands like OH^-, $CO_3^=$ and NH_3 was also studied. The polarographic waves obtained were irreversible in all cases. pH had little effect on the half-wave potential, indicating that the same species of complexes exists at all pH values. The formula of the complex was determined using the equations developed by Subrahmanya in this laboratory for irreversible systems. It was found that one group of $P_4O_{10}^{4-}$ was attached to each nickel ion. Presence of $CO_3^=$ or OH^- in solution did not alter the nature of the complex species. In ammonia-ammonium chloride solutions evidence for the formation of $[Ni(P_4O_{12})\ (NH_3)_2]^{2-}$ was obtained.

139. Polarographic behaviour of tetrametaphosphate complexes of lead.

C. S. RAMANATHAN and R. S. SUBRAHMANYA, Bangalore.

Sodium tetrametaphosphate is the second member of the homologous ring phosphate system and in common with them, tetrametaphosphate exhibits the property of sequestering metal ions in solutions. The nature of the complexes formed by the common metal ions with tetrametaphosphate has been investigated and in the present paper, the results obtained in the case of lead have been presented, using the polarographic method of investigation of metallic complexes.

Single reversible polarographic waves have been observed in the case of lead. One $P_4O_{12}^{4-}$ is found to be attached to each metal ion at all pH values below 11. Above pH 11, only biplumbite ion exists in solution. The effect of competing ligands like $CO_3^=$ and NH_3 was investigated and evidence for the formation of the following mixed complexes was obtained

$$[Pb(P_4O_{12})\ (NH_3)_2]^{2-} \text{ and } [Pb(P_4O_{12})\ (CO_3)]^{4-}$$

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140. Absorption Spectra of the Oximes of Cyanacetic Acid derivatives.

A. M. TALATI and T. I. PATEL, Baroda.

Alpha-isonitroso cyanacetic acid derivatives have been prepared and their ultra-violet absorption spectra in water and methanol are obtained using Beckmann DU spectrophotometer. The spectra of these oximes are compared with those of the monoximes and the dioximes derived from acetoacetanilide (Dave and Talati, J. Chem. Soc., 1960, 900) and the effects of the different groups and the solvents on the absorption bands are considered.

141. Studies on the Double Layer of Titanium Dioxide Suspensions.

BHAGWAN SWAROOP SRIVASTAVA, Lucknow.

An attempt was made to prepare sols with the same characteristics in order to avoid the complexities present in the system due to uncertainty of the number of water molecules associated with titanium dioxide. The changes occurring in the double layer of these suspensions were followed as a function of concentration of various surfactants, using potentiometric method.

142. Cohesive-energy-densities of High Polymers.

S. PATRA, S. B. RATH and D. MANGARAJ, Cuttack.

A knowledge of intermolecular forces in high polymers is essential to correlate their bulk properties with the chemical structure of the repeating unit. Cohesive-energy-density is used as a measure of intermolecular forces. However, methods used for estimating this quantity for simple liquids and solids, cannot be applied to polymers. Indirect methods like swelling and solution viscosity measurements and initial-phase-separation titration have been used in past to estimate cohesive energies density of polymers. In most cases the success is limited because measurements have been done in polar systems, where the basic Scatchard-Hildebrand relation for heat of mixing does not apply. In the present work, attempt has been made to confine these measurements in solvents which are structurally alike among themselves and with the repeating unit of the polymer. Thus a series of alkyl esters have been used in case of ester polymers and hydrocarbons in case of Natural Rubber. Swelling measurements have been done with two polymers, polyvinyl acetate and polyethoxyethyl-methacrylate. Solution viscosity measurements, using a modified Ubeholde type viscometer, have been carried out with 4 polymers, namely polyvinyl acetate, polyethylacrylate, polymethylacrylate and natural rubber. Initialphase-separation titrations have been done with latter polymers. Except the linear polyvinyl acetate and natural rubber, all other polymers were synthesised in the laboratory. A number of solvents were also synthesised. The cohesive-energy density values obtained by different measurements agreed within experimental error among themselves and with the existing literature data. The mean values of cohesive energy densities for polyvinyl-acetate, polymethyl acrylate, polyethyl-acrylate, polyethoxy-ethyl-methacrylate and natural rubber are 87·4, 101·1, 88·3, 65·6 cal/cc respectively. In conclusion it may be said that choice of solvents is essential for precise measurements of cohesive energy density in high polymers, using any of the methods mentioned above.

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143. Studies on Metal Thiourea Complexes.

C. E. S. VAZ and S. N. BANERJEE, Kharagpur.

Different types of thiourea complexes with mercuric chloride have been reported by different workers. In the present investigation by Job's method of continuous variation using molar conductivity as an indicative property it has been possible to obtain only three sharp peaks at concentration of $HgCl_2$: Thiourea corresponding to 1 :1, 1 :2 and 1 :4 ratios. It has not been possible, by this method, to detect complexes with 1 :0·5, 1 :1·5 and 1 :3 ratios reported in the literature. Thermometric and conductometric titrations have also been attempted by adding thiourea to mercuric chloride solutions at different concentrations with no useful results, as the reaction rate between $HgCl_2$ and thiourea was found to be too slow. Investigations to study complex formation between thiourea and various substituted thioureas with different metal salts, to study the effect of the substituents on the stability of the complexes and to elucidate the structure of these complexes are in progress.

144. Amphoterism of Hydrous Thorium Oxide and the adsorption of Fuchsine by the Hydrous Oxide.

RAMESHWAR PRASAD and ARUN K. DEY, Allahabad.

Four samples A, B, C and D of hydrous thorium oxide were prepared by the interaction of solutions of thorium chloride with 10% deficient, equivalent, 5% excess and 10% excess of alkali respectively. It has been observed that the adsorption diminishes with rise in temperature in all the samples. The results have been found to support the amphoterism of hydrous thorium oxide and to suggest that the hydrous oxide behaves as isoelectric in sample C.

145. Behaviour of p-Nitrobenzene Azochromotropic Acid (Chromotrope 2B) as a Colloidal Electrolyte.

SURESH C. SRIVASTAVA, ROSHAN LAL SETH and ARUN K. DEY, Allahabad.

Measurements of electrical conductance were performed with aqueous solutions of p-nitrobenzene azochromotropic acid (Cromotrope 2B), which has been observed to behave as a colloidal electrolyte. The compound, well known for its chromophoric properties, does not obey Beer's law in concentrated solutions, and the square root of concentration *versus* equivalent conductance curve is not linear but is similar to the curves of colloidal electrolytes.

The temperature of zero conductance, extrapolated from measurements of conductance at five different temperatures, comes out to be $-16{\cdot}5^{\circ}C$. The temperature coefficient per degree centigrade per 100 of the conductance at 35°C, has been observed to be below 2·0.

146. 7-Iodo 8-Hydroxy Quinoline 5-Sulphonic Acid (Ferron) as a Colloidal Electrolyte.

SURESH C. SRIVASTAVA, ROSHAN LAL SETH and ARUN K. DEY, Allahabad.

Electrical conductance studies have been performed to investigate the nature of aqueous solutions of 7-iodo 8-hydroxy quinoline 5-sulphonic acid (Ferron). The

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reagent has been found to behave as a colloidal electrolyte and does not obey Beer's law in concentrated solutions. The curve between the square root of concentration and equivalent conductance is not linear and resembles those of colloidal electrolytes. The temperature of zero conductance has also been determined to be $-32°C$. The temperature coefficient per degree centigrade per 100 of the conductance at 35°C ranges between 1·56 and 1·72.

147. Study on the Citrate Complex of Strontium.

RABINDRA K. PATTNAIK and S. PANI, Sambalpur.

The Citrate complex of Strontium has been investigated by the pH titration method at the pH 7·2 to 7·3.

The equilibrium constant of the reaction $Sr^{++} + Cit^{3-} \rightleftharpoons SrCit^{-}$ is determined to be $5{\cdot}23 \times 10^2$.

148. Study on the Citrate Complex of Magnesium.

RABINDRA K. PATTNAIK and S. PANI, Sambalpur.

The Citrate complex of Magnesium is studied by the pH titration method at pH 6·9 to 7·1. There is no liberation of proton due to complex formation. The equilibrium constant of the reaction $Mg^{++} + Cit^{3-} \rightleftharpoons MgCit^{-}$ is found to be $5{\cdot}89 \times 10^3$.

149. Polarography of Cerium in Lithium Sulphate.

O. P. AGRAWAL and R. C. KAPOOR, Allahabad.

Polarographic behaviour of ammonium hexanitratocerate and double sulphate of cerium (ceric ammonium sulphate), was studied using 0·1 M lithium sulphate as supporting electrolyte. Two waves were observed, one present at zero applied e.m.f. and second starting at $-1{\cdot}4$ vols. The first wave is observed at concentrations above 2×10^{-4} M and represents the reduction of ceric into cerous stage. Ammonium hexanitratocerate gives second wave, only at very low concentrations. At concentrations higher than 2×10^{-4} M it is overlapped by hydrogen evolution. In case of ceric ammonium sulphate the second wave is visible even at higher concentrations, and thus both the waves are visible at concentration 3×10^{-4} M and above. The limiting current of the second wave is twelve to fourteen times of that of the first wave and $E_1/_2$ value is $-1{\cdot}575 \pm 0{\cdot}005$ volt for ceric ammonium sulphate and $-1{\cdot}574 \pm 0{\cdot}01$ volt for ammonium hexanitratocerate. The irreversible second wave is proposed to be a catalytic hydrogen wave.

150. The Polarographic Behaviour of Thioacetamide.

T. D. SETH and R. C. KAPOOR, Allahabad.

The polarographic behaviour of thioacetamide was studied in phosphate buffer and potassium nitrate solution. The pH was maintained at 6·8 where the stability of thioacetamide is maximum. Current-voltage curves were taken at different concentrations of thioacetamide.

Thioacetamide gives a well-defined anodic wave which is preceded by a pre-wave. The anodic wave is probably due to the formation of a compound between thioacetamide and mercury. The pre-wave appears to be an adsorption wave,

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151. Estimation of Acetone-Ethanol and n-Butanol.

S. C. MEHTA and P. S. MENE, Nagpur.

Various methods have been reviewed for the estimation of Acetone-Ethanol and n-Butanol in the ternary mixture. It is found that if one of the components is estimated by chemical method, the composition of the ternary mixture can be obtained by use of the one of the physical properties like viscosity, solubility. Other physical properties like refractive index, density and surface tension are not of any help, since these properties are almost identical or the range is so small that the accuracy in estimation is limited. Bogin has taken the advantage of relative solubility of these constituents in water. Bogin's method is suitable for solutions containing 20 o 36 per cent of acetone and at least 50 per cent of n-Butanol. Mixtures of such compositions will give sharp end point when titrated against distilled water. For low concentration of acetone from 0 to 25 per cent viscosity can be used as one of the parameters for estimating the ternary mixtures accurately and rapidly. The same method can be extended to mixtures containing homologous components whether other physical properties are almost identical and where the presence of other component may interfere by chemical estimation. For other concentrations the mixture may be diluted by adding n-Butanol to bring down the composition of the mixture within this working limit.

152. Conductometric Titration of Nitrite with HCl.

B. P. GYANI, Patna and R. K. PRASAD, Muzaffarpur.

When sodium nitrite (cell) is titrated conductometrically with HCl at room temperature (28°C) the acid required is 25-30% less than the theoretical value for the reaction $NaNO_2 + H+ \rightleftharpoons HNO_2 + Na+$. The discrepancy is only 20% at 0°C. This may be due to decomposition of the nitrous acid liberated at first, $3HNO_2 = HNO_3 + 2NO + H_2O$. The gaseous product so obtained increases the resistance of the solution. The reverse titration is also anomalous.

153. Oxidation of Mandelic Acid by Acid Dichromate in presence of Manganous Sulphate.

B. P. GYANI, Ranchi and SUKHNANDAN PRASAD, Muzaffarpur.

The oxidation of mandelic acid by dichromate is slow at room temperature but when manganous sulphate is added it is quite rapid. Depending upon the quantities of sulphuric acid and manganous sulphate added, mandelic acid may be quantitatively oxidized either to benzoyl formic acid or benzoic acid, or a mixture of the two.

154. Potentrometric Titration of Sodium Nitrite with HCl in presence of Urea and Kl.

B. P. GYANI, Ranchi and R. K. PRASAD, Muzaffarpur.

Since the nitrite ions and nitrous acid are both liable to oxidation in solution the mineral acid requirement for liberating nitrous acid from sodium nitrite is usually less than the theoretical value. When urea or Kl are present, the acid requirement improves. The improvement is less in the case of urea. Values approaching the theoretical are obtained in the case of Kl. These results may be

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ascribed to a slow reaction of the liberated HNO_2 with urea and a much faster one with KI. Nitrite may thus be determined with an accuracy of 1·2% even in molar solutions and at room temperature.

155. Physico-chemical studies on the decomposition of Blue Peroxy Chromic Acid —Part I : Conductometric study on the decomposition of Ethereal Blue Peroxychromic Acid in aqueous medium.

C. V. P. PILLAI and M. C. SAXENA, Saugar

Decomposition of the so-called blue peroxy chromic acid has been studied conductometrically in aqueous medium at 20°C, 25°C and 35°C. The ratio between ethereal peroxychromic acid solution and water was 1 : 1 in each case. The observations at 25°C were repeated by varying the amount of ethereal peroxychromic acid and water in the ratios 1 :2, 1 :3 and 1 :4.

The graphic representation between the observed conductivity and time in each case suggested that the decomposition occurred in three definite stages. This has been explained by assuming the formula of the blue peroxychromic acid to be $Cr_2(Cr_2O_{10})_3$. The decomposition can be represented as :

$$Cr_2(Cr_2O_{10})_3 \longrightarrow Cr_2(Cr_2O_9)_3 + 3O \ldots\ldots \text{1st stage}$$

$$Cr_2(Cr_2O_9)_3 \longrightarrow Cr_2(Cr_2O_8)_3 + 3O \ldots\ldots \text{2nd stage}$$

and $$Cr_2(Cr_2O_8)_3 \longrightarrow Cr_2(Cr_2O_7)_3 + 3O \ldots\ldots \text{3rd stage}$$

The final decomposition product being chromium-di-chromate $Cr_2(Cr_2O_7)_3$.

156. Thermodynamics and Solid-state Chemistry of Addition Compounds.

R. P. RASTOGI, R. K. NIGAM, PARMJIT S. BASSI, RAJINDER NATH SHARMA and SATISH KUMAR SHARMA, Chandigarh.

The thermodynamics and the solid state chemistry of 1 : 1 benzophenone-diphenylamine complex has been studied. A thermistor calorimeter has been described for the accurate measurement of heat of fusion. The heat of fusion and the entropy of fusion of the compound have been found to be 7710±50 cal/mole and 24·6 ± ·2 cal./deg./mole respectively. The entropy of fusion of diphenylamine and benzophenone are found to be 13·7±·2 and 12·6±·2 cal./deg./gm. mole respectively. This is discussed from statistical mechanical considerations.

The addition reaction between benzophenone and diphenylamine is found to occur in the solid state. A technique for measuring the reaction temperature is described. The reaction temperature is found to be 3·4°C. The progress of reaction in the solid-state has been investigated at 10°C, which is found to be very slow. A study of micro-structures with the help of photo-micrography has also been made. The reactants are capable of diffusing through product layer but it is a very slow process.

With a view to elucidate the role of nuclei-formation and growth, experiments for the study of rate of nuclei-formation in melts of the addition compound and the linear rate of advance of solid-liquid interface were also performed.

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157. Charge and Stability of Colloids. Part XXVIII. Effect of temperature on coagulation constants of Ferric hydroxide sol.

B. P. YADAVA and RUPENDRA KUMAR VERMA, Lucknow.

A. Bhattacharya and A. K. Bhattacharya* have verified the validity of the equation $\frac{1}{c-a} = \frac{n}{m}t + \frac{1}{m}$ by calculating the values of the constants a, m and n, employing the data available in the literature. We have expreimentally determined the variation in viscosity with time while coagulating the dialysed sol of ferric hyydroxide at different temperatures. It has been found that the values of critical stability concentration 'a' decreases regularly in a linear manner with the rise of temperature. The values of the constants 'm' and 'n' also decrease with the rise of temperature. The decrease in the values of 'a' indicates that maximum concentration of coagulating ions of the electrolyte, which causes no coagulation, falls with the rise of temperature. It means that the sol loses its stability as the temperature increases. Freundlich† observed that the excess of kinetic energy above the critical value, which is responsible for coagulation of the sol, increases with the increase of coagulating ion concentration. We observed that the maximum stability concentration is directly related to the temperature and kinetic energy of the coagulating particles. The decrease in the value of 'm' with the rise in temperature indicates that less concentration of coagulating ion above the critical stability concentration is required to cause coagulation, while the decrease in the value of 'n' shows that greater degree of aggregation takes place at higher temperatures.

158. Anion Electrodes—Part I—Mercury-mercurous arsenate electrode.

G. CHOUDHARY, S. N. DAS and S. SWAROOPA, Patna.

A new anion electrode has been set up constituting of mercury in conjunction with mercury arsenate (ous). The e.m.f. measurement are quite promising and are impregnated with interesting idea regarding structure of mercurous arsenate. Work under more stringent conditions yielding results of high accuracy is in progress.

159. A study of the Electrolytic preparation of Bromates using Graphite and/or Carbon Substrate Lead Dioxide Anodes.

H. V. K. UDUPA, Karaikudi.

Lead dioxide deposited on graphite or carbon substrate has been used as anodes in the electrolytic preparation of bromates from bromide.

The influence of anodic current density, temperature, and addition agents on the current efficiency of bromate formation has been studied. Use of lead dioxide anodes permits the use of high anode current density (10 to 40 amp/dm^2), employing high electrolyte temperature (upto 60°C) under which conditions mere graphite or carbon as anode would disintegrate considerably.

Current efficiency of 93 to 96% has been obtained for bromate formation. The isolation of the product is described and the purity of the same reported. Energy consumption (d.c.) for potassium bromate and sodium bromate are 3·87· kwh/kg and 4·32 kwh/kg respectively.

A cell in which nearly 0·5 kg of potassium bromate could be produced by electrolysing for 8 hours is described.

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* A. Bhattacharya and A. K. Bhattacharya; J. Colloidal Science, **11**, 124 (1956).
† Kolloid Z. Vol. 23, 163 (1918).

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160. Studies on the Kinetics of Oxidation of Mercurous Ion by Persulphate Ion—Part I.

J. C. GUPTA and S. P. SRIVASTAVA, Naini Tal.

The kinetics of the hitherto unstudied oxidation of mercurous nitrate by potassium persulphate, both uncatalysed and silver ion catalysed has been investigated. The results are found to be reproducible when the necessary precautions about the extreme purity of the materials and the medium are taken. It is found that the uncatalysed reaction is of a measurable velocity at 40°C at rather high concentrations of the reactants The reaction is found to be slightly influenced by light, being slightly slower in the dark.

The order of the recation with respect to mercurous ion for the silver catalysed reaction is found to be 0·5, while the order with respect to persulphate ion is found to be approximately one. However, the reaction is found to be attended with an induction period at higher concentrations of mercurous nitrate and the extent of this induction period increases with an increase in mercurous ion concentration. The rate of the reaction is found to increase with an increase in silver nitrate concentration.

161. Electron Diffraction Studies of Chemical Reactions on Single Crystal Surfaces of Zinc.

H. K. ACHARYA, Poona.

The single crystals of zinc have been prepared by slow cooking of the molten metal and the crystallographic orientation, degree of roughness, crystal perfection of the cleavage face and (001) face of the (1012) twin of zinc and the chemical reactions by (i) thermal oxidation in air, (ii) by treatment with H_2S gas or with benzene followed by oxidation in air have been followed by electron diffraction method.

The reaction products in each case have been identified and their orientations with respect to the substrate have been determined.

The important result has been established that even when examined in vacuo within five minutes after cleavage, these surfaces which are relatively perfect since they yielded clear Kikuchi bands were invariably covered with an extremely thin optically invisible layer of highly (001) oriented zinc oxide crystals having an exceedingly smooth surface parallel to the substrate. The hitherto unnoticed fact, that while the Kikuchi bands correspond to the metallic zinc, the strongly elongated spots in the same pattern are due to a zinc oxide lattice has also been established.

When heated in air at 200° for 12 hours the ZnO spot pattern on the cleavage plane becomes sharp and also less elongated, but otherwise remains unchanged in orientation and thin over much of the surface. This result indicates the protective action of the oriented ZnO film.

The oxide layer of zinc cleavage planes remains unchanged even after two hours heating in air at 400°C and only after long further heating at this temperature did the ZnO ring pattern appear. The ZnO spot patterns are, however, still present.

A cleavage face of zinc which had been treated with crystallisable benzene gave on subsequent heating in air at 400°C for fifteen minutes an arced ring pattern of zinc oxide showing two degree (101) and (001) orientations. Another cleavage face which was exposed to dilute hydrogen sulphide gas in air gave on subsequent heating in air at 400°C for a short time an oxide pattern with (101)

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and (001) orientations closely similar to those obtained from the cleavage face treated with benzene.

The (001) plance of the (1012) twin perpendicular to the cleavage plane gives Kikuchi bands and zinc oxide spot pattern exactly similar to that from the cleavage planes, but this plane also gave very sharp and round spot due to zinc and those relatively rough parts of the surfaces. On heating in air at 400°C for fifteen minutes the (001) face of (1012) twin gave an arced ring pattern due to (001) orientation, but after one hour heating at the same temperature only ring pattern without any orientation remained. This result is attributed to the roughness of much of the (001) face of (1012) twin with respect to (001) cleavage plane of zinc crystal.

162. Thermodynamic Interaction Parameters of Polystyrene in p-Xylene.

D. D. KHANOLKAR and T. S. MURLIDHARAN, Poona.

Intrinsic viscosities of four different high molecular weight fractions of polystyrene in p-zylene at 30°, 34° and 40°C were determined from solution viscosities measured in a precision bore capillary viscometer of Ostwald type. These data were employed to calculate Flory temperature θ, entropy of dilution Ψ_1, and heat of dilution k_1 with the help of equations given by Flory and coworkers for the evaluation of these parameters. The values of these parameters, namely $\theta = 177°K$, $\Psi_1 = 0{\cdot}11$ and $k_1 = 0{\cdot}065$ are in good agreement with those reported by Flory et al. for polystyrene in benzene and toluene.

163. Electron Diffraction Studies of Chemical Reactions on Single Crystal Surface of Bismuth.

H. K. ACHARYA, Poona.

The single crystals of bismuth were prepared by two different methods : (i) by casting the molten metal on glass or mica surfaces followed by slow cooling, and (ii) by a modified Bridgman method.

The cast surfaces of bismuth single crystals prepared by method (i), gave clear Kikuchi bands corresponding to the pseudocubic (100) face parallel to or within 20° to the substrate. The cleavage faces obtained from bismuth single crystals prepared by method (ii), gave Kikuchi bands corresponding to (111) plane, but did not show spot pattern due to an oxide layer.

When heated in air at 250°C for one hour the (100) face gave a random oxide pattern corresponding to Bi_2O_3 having a face centred cubic structure with $a = 5{\cdot}40A$. The cleavage faces (111) heated at the same temperature for the same length of time gave only diffuse hallows which became clear rings only after four hours' heating at the same temperature.

When exposed to dry iodine vapour the (100) face gave a random ring pattern due to B_iI_3 while the cleavage plane (111) being similarly treated gave a pattern showing 2° (111) orientation of B_iI_3.

When exposed to moist iodine vapour or iodine vapour from its solution in benzene, alcohol or acetone or even when dipped in a solution of iodine in benzene, the (100) face of bismuth gave ring patterns due to B_1I_3. The (100) face exposed to moist chlorine gas or bromine vapour or even when etched with 1 :1 hydrochloric acid or saturated bromine water, gave ring patterns due to oxychloride or oxy-bromide in respective cases.

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164. Thermal Oxidation of Antimony Single Crystals.

H. K. ACHARYA, Poona.

The thermal oxidation of the cleavage plane of antimony single crystals has been followed by electron diffraction method. The results show that the antimony cleavage (111) planes which are atomically smooth, give clear Kikuchi bands, but do not show a pattern due to oxide layer which, even if present at all, must have been less than 10A thick. On being heated in air at 400°C for a short time the cleavage face gave an arced ring pattern showing two-degree (111) orientation of the Sb_2O_3. The ring pattern of Sb_2O_3 corresponds to a cubic structure with a=11·20A agreeing with X-ray data.

165. Transference Number of Ortho Phosphoric Acid.

J. N. SAHAY, Ranchi.

The present work arose out of certain observations by Kerker and Espenscheid (*J. Amer. Chem. Soc.* 1958, *80,* 776) that they attempted to get independent data for the transference number of phosphoric acid by the Hittorf method but were unsuccessful in preparing nongassing electrodes. During the present investigations transference number of aqueous solutions of orthophosphoric acid over the range of molar concentration employed by Kerker and Espenscheid have been obtained by this method using amalgamated zinc rod as anode. Mercury contained in a specially designed trumpet-shaped tube covered with concentrated solution of zinc chloride and on the top of this, solution of orthophosphoric acid avoiding mixing served as cathode. This arrangement prevented the evolution of hydrogen and production of OH. The result show high value for the transference number of H^+ and low for $H_2PO_4^-$ which could be explained if we account for the transference of additional phosphoric acid to the cathode with the possibility of ionic species $H_4PO_4^+$.

166. Studies on the coagulation of Colloids with special reference to the variation of time of coagulation with concentration of electrolytes as applied to Zinc-ferrocyanide sol.

S. L. GUPTA, Pilani.

This piece of work relates the slow coagulation of Zinc-ferrocyanide sol by various uni-bi-ter and tetra-valent precipitating ions. The results obtained with various electrolytes are interesting enough to provoke thought on the aspect of slow coagulation in the light of the empirical equation;

$$C = a + \frac{m.\ 1/t}{n + 1/t}$$

suggested by Bhattacharya and Co-workers, where 'C' is the precipitation—concentration of the electrolyte; 't' is the time of coagulation and 'a', 'm' and 'n' are constants which depend on such factors as are connected with its stability and coagulation. This equation represents a rectangular hyperbola and it is interesting to find that the graphs of C against $\frac{1}{t}$ drawn from experimental results are indeed of hyperbolic nature. A method for the evaluation of the values of the constants is also given.

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167. Mixed Mesomorphism—II.

J. S. DAVE and J. M. LOHAR, Baroda.

Continuing our work further (Proc. Nat. Acad. Sci. India, *29A*, Part I, pp. 35-38, 1960, ibid., *29A*, Part III, 1960) we have examined binary systems in which both the components are liquid crystals. Although continuous series of mixed liquid crystals are formed over the entire range of concentration, it is observed that there takes place a depression in the transition line when the admixed molecules depart from the criterion of similarity; this can be attributed to the difficulty in packing of the molecules. Slope of the transition line can be measured from either side and the group slope values could be deduced therefrom. These values are found to be comparable with those obtained from the study of the binary mixtures where one component is a non-liquid crystal. This suggests that the specific effect of the terminal groups is operative even in the case of liquid crystalline substances.

168. Effect of a.c. ripple on the behaviour of Bromothymol Blue at the dropping Mercury Electrode.

S. L. GUPTA and L. SARASWATHI, Pilani.

This piece of work relates to the effect of 50 cycle a.c. ripple of varying magnitudes i.e. from 10 mv. to 150 mv. (r.m.s.) on the behaviour of bromothymol blue at the dropping mercury electrode. Bromothymol blue affects the differential capacity of the dropping mercury electrode in two ways. Firstly at about the electro-capillary zero there is a strong lowering of the capacity due to adsorption of B.T.B. Secondly, at a higher cathodic potential, there is a sharp increase in the differential capacity leading to a maximum followed by a sharp fall in the capacity.

It is seen in general that the lowering of the capacity as well as the magnitude of the maximum diminish with increase in a.c. ripple. There is practically no shift in the peak potential with increase in a.c. ripple. The diminution in the magnitude of the maximum with increase in a.c. ripple is in accordance with the theory of maximum based on adsorption and desorption phenomena at the dropping mercury electrode.

169. Complex forming property of Graham Salt : Part IV—System $CaCl_2$-H_2O-$(NaPO_3)_n$

A. C. CHATTERJI and R. M. BHATNAGAR, Lucknow.

Binding of calcium ion by Graham salt has been studied in detail. pH titrations, conductometric titrations, Job's method of continued variation and solubility method were used in the investigation. The titrations were carried out with various samples of Graham salt having different weight average molecular weights ranging from 6,000 to 16,000. Following results were obtained :

Method	Ratio (Ca^{++} : PO_3^-)
1. pH titrations	1 : 2 (Pption) 1 : 3 (Dissolution)
2. Conductometric titrations ...	1 : 2 ,, 1 : 3 ,, and 1 : 4
3. Job's method (Conductivity)	a peak at 1 : 2

The precipitate obtained at the ratio 1 : 2 which contained no sodium and appeared to be pure calcium polymeta-phosphate on analysis was used. Its solu-

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bility in a known amount of Graham salt was determined. By this method, values of log K at two different temperatures were determined; the other calculated thermodynamic constants from log K values are given below for 1 : 3 complex using standard equations.

Temp.	p (coord. no.)	log K	ΔF	ΔH	ΔS
35°C	1	7·92	−11·09	−13·59	−8
45°C	1	7·62	K. cal.	K. cal.	cal.

170. Effect of Acids on the rate of reaction between Formic Acid and Chromic Acid. Part—III.

A. V. MAHAJANI, Sagar.

A kinetic study of the effect of phosphoric acid on the rate of reaction between formic acid and chromic acid has been made. In this reaction the order with respect to chromic acid is one. The presence of phosphoric acid, at the experimental concentration range of 0·08 to 3·20 N, in the reaction mixture is found to have no effect on the order of the reaction. The velocity coefficient is however, found to increase with the increasing concentration of phosphoric acid. As phosphoric acid does not react with either of the reactants, it is a positive catalyst in this reaction. The temperature coefficient of the reaction is not changed by its presence in the reaction mixture.

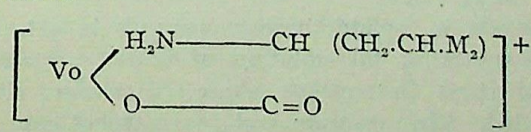
As phosphoric acid does not alter the order and the temperature coefficient of the reaction between formic acid, and chromic acid, it appears that the intermediate steps of the reaction are essentially the same in the presence of the added acid as in its absence.

171. Spectrophotometric and Conductometric Study of the reaction between Vanadyl Sulphate and Leucine.

P. K. BHATTACHARYA, Saugor.

Th amino acids are known to form complexes with number of metal ions. The present work reports the results of the interaction between leucine and vanadyl sulphate.

The system under investigation has been studied by using Job's continuous variation methods in conductometric and spectrophotometric measurements. The method has been worked out for three different sets of equimolar solutions of vanadyl sulphate and leucine namely, M/30, M/40 and M/60 in conductometric measurements and for M/10 solutions in spectrophotometric measurements at wavelengths 750 mμ, 800mμ and 850 mμ. The results of the aforesaid investigation are unequivocal suggesting the formation of 1 : 1 complex, which may be represented by the formula



The dissociation constant, K for vanadyl complex has been determined, its average value being $15{\cdot}37\times10^{-4}$ at 28°C.

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172. Studies on Coordination Compounds of Uranyl Acetate with Organic Acids—Part I. The System :—Uranyl acetate-mandelic acid-water.

C. S. PANDE and S. K. MISRA, Lucknow.

Physico-chemical studies of the solutions of uranyl acetate and mandelic acid were carried out by following Monovariation Method of Nayar and Pandey (Proc. Ind. Acad. Sci., *27-A*, 286, 1948). The properties studied were conductivity and pH. Further, conductometric and electrometric titrations were also carried out for (1 : 1) and (1 : 2) molecular ratios of uranyl acetate and mandelic acid and the curves examined.

After ascertaining the evidence of the formation of complexes at the molecular ratios of (1 : 1) and (1 : 2) of uranyl acetate and mandelic acid, attempts were made to isolate these compounds in solid state by evaporating the solutions in the stoichiometric ratios of 1 : 1) and (1 : 2). The crystals formed were separated and the compounds analysed for the contents of uranium and mandelic acid. The compounds prepared have been assigned the formulae :—

1. UO_2 $(C_8H_6O_3)$ $2H_2O$ and
2. UO_2 $(C_8H_6O_3)_2$.

173. Studies on Coordination Compounds of Uranyl Acetate with Organic Acids—Part II. The System :—Uranyl acetate-lactic acid-water.

C. S. PANDE and S. K. MISRA, Lucknow.

Conductometric, colorimetric and pH studies of this system revealed the evidence of the formation of two complex compounds at the molecular ratios of (1 : 1) and (1 : 2) of uranyl acetate and lactic acid. The method employed was Nayar and Pande's Monovariation Method.

These compounds have been isolated in the pure solid state by evaporation. The uranium and lactic acid contents were then estimated for both of them to assign them possible formulae : The formulae assigned to them are as follows :—

(1) UO_2 $(C_3H_5O_3)$ $2H_2O$ and
(2) UO_2 $(C_3H_4O_3)_2$.

174. Studies on Coordination Compounds of Uranyl Acetate with some Organic Substances. The System :—Uranyl acetate-pyrocatechol-water.

C. S. PANDE and S. K. MISRA, Lucknow.

The results of such physico-chemical properties as conductivity, colorimetry and pH revealed the evidence of the formation of two complex compounds in solution at molar ratios of (1 : 1) and (1 : 2) of uranyl acetate and pyrocatechol. Further, conductometric and pH titrations were also carried out which also gave the same evidence.

Attempts were made to isolate these compounds in solution. (1 : 1) compound was prepared by evaporating the solution of uranyl acetate and pyrocatechol in the stoichiometry of (1 :1) in aqueous phase. However, all attempts to prepare (1 : 2) compound failed. The uranium and pyrocatechol content of the (1 : 1) compound was determined which corresponded with the formula :

UO_2 $(C_6H_4O_2)$.

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175. Polarographic Behaviour of Metal-Amino Acid Complexes. Part I—Cadmium.

G. NAGESWARA RAO and R. S. SUBRAHMANYA, Bangalore.

Amino acids form strong chelates with several metal ions. The metal chelates formed are of great biochemical interest, since proteins are made up of essentially simple amino acid molecules. The polarographic method is ideally suited for the investigation of such complexes. In this paper are reported the results of the study of polarographic behaviour of cadmium in presence of aspartic acid, asparigine and valine. The ionic strength of the solution was kept at unity using potassium nitrate. 0·001% gelatin has been included to suppress the polarographic maximum. Cadmium gives a single reversible wave with all the three complexing agents. The shift in the half-wave potential with an increase in pH of the solution, and also the concentration of complexing agents, indicates that two amino acid molecules are chelated with the metal ion in case of aspartic acid, and three molecules in case of valine and asparigine. The dissociation constants of the complexes formed have been calculated using Lingane's equation.

176. Polarographic Behaviour of Metal-Amino Acid Complexes. Part II—Lead.

G. NAGESWARA RAO and R. S. SUBRAHMANYA, Bangalore.

The polarographic behaviour of lead in presence of alanine, aspartic acid and asparigine as complexing agents has been investigated at various pH values employing potassium nitrate as indifferent electrolyte. 0·001% gelatin is added to suppress the polarographic maximum. These amino acids are capable of forming chelates with metals. In presence of all the three amino acids lead gives reversible polarographic wave. The shift in the half-wave potential with an increase in the concentration of the complexing agent and pH indicates chelate formation in which two molecules of the amino acid take part in case of asparigine and one molecule in case of alanine and aspartic acid. The dissociation constant was calculated by employing Lingane's equation.

177. Paper Chromatographic Studies on Liesegang Ring Formation.

SAMIR KUMAR MUKHERJEE, Roorkee.

An investigation of the nature of the rhythmic patterns obtained by diffusing the reactant solution on the circular filter papers impregnated with the precipitating agents and a protective colloid (2% agar agar) has been made. The systems : $AgNO_3$-K_2CrO_4, $Pb(NO_3)_2$-K_2CrO_4, $Ba(NO_3)_2$-K_2CrO_4, $Co(NO_3)_2$-$K_4Fe(CN)_6$ and $Co(NO_3)_2$-$K_3Fe(CN)_6$ were studied. The following important observations were noted :

(1) Radial rhythmicity in all the cases when potassium chromate was used as precipitating agent; (2) The clear radial gaps are more marked in the case of $Pb(NO_3)_2$-K_2CrO_4 and $Ba(NO_3)_2$-K_2CrO_4; (3) The radial gaps are closer as the concentration of Pb++ solution is increased; (4) In between the gaps or spaces beautiful rhythmic patterns were obtained, specially in the case of $AgNO_3$-K_2CrO_4 the patterns are more marked; (5) Ring rhythmicity with $Co(NO_3)_2$-$K_4Fe(CN)_6$; (6) Rhythmic patterns (radial type, but not so clear gaps) with cobalt-ferricyanide.

An attempt has been made to explain the causes of radial and ring rhythmicity on filter papers on the basis of coagulation theory of Dhar and Chatterji.

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178. Liquid—liquid Equilibrium Studies.

K. N. ROY and B. N. GHOSH, Bombay.

Liquid-liquid equilibrium data are of importance both from the fundamental aspect of Phase-rule study and also in industry. Phase eqilibrium data for a few ternary liquid-liquid systems have been obtained. The tie-line data for the different systems have been correlated by the methods of Hand and Othmer-Tobias; the corresponding equations have been deduced and their limitations discussed.

179. Electromigration and Diffusion of Na+ Ions in Fused Alkali Nitrates.

H. J. ARNIKAR and D. K. SHARMA Varanasi.

Employing the tracer technique developed earlier in these laboratories, the electromigration and diffusion of Na+ ions, labelled with Na-22, were studied in fused sodium and potassium nitrates as well as in a 45·5+54·5% eutectic mixture of the two. The studies were effected under conditions of both (1) constant 'T' of 350°C and (2) constant reduced temperature 'Θ' of 1·2 (temp. used/M.P. of the medium). Data for the diffusion coefficient 'D' and relative ionic mobility 'v' are presented for the three media for constant T and Θ. It is significant that both v and D vary in the order for the media.

$$NaNO_3 > \text{eutectic} > KNO_3$$

The contrary influence of rise of T and of Θ are discussed in the case of the eutectic medium in particular. To interpret the marked assymmetry in the Gaussian distribution following electromigration, observed also in other fused, aqueous and gel media, a correction ± has been suggested to D in the expression.

$$a\,(x, t) = \frac{a_0}{\sqrt{4\pi Dt}} e^{-x^2/4Dt}$$

Examination of the v and D values further indicate a marked deviation from the simple Einstein-Nernst relation. The deviation factor f in the relation.

$$v/D = f\,\frac{(Ze)}{kT}$$

is of the order of 2 for the KNO_3 and 2·5 for the $NaNO_3$ and the eutectic. The significance of this deviation is discussed.

180. Electrolysis of Ammonium Sulphate solution.

B. P.GYANI, Ranchi and (Miss) RANI MISRA, Patna.

The current-time graphs of electrolysis of undisturbed solutions of ammonium sulphate are similar to those of potassium thiocyanate and potassium hydroxide (cf. these abstracts, 1959, p. 92; 1960, p. 103; 1961, p. 125, 126). The initial rise is hardly observable, but there is again a steep fall in 40-60 minutes. When phenolphthalein is present there is only an initial pink zone at the cathode which does not migrate towards the anode.

Since no insoluble products are formed the steep fall must be due to formation of an almost electrolyte-free zone between the electrodes. Liberation of sulphuric acid at the anode prevents the movement of the pink zone towards that side.

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181. Solvent and Salt effects of the unimolecular solvolysis of t-butyl chloride.

B. B. PANDA and B. NAYAK, Cuttack.

The kinetics of solvolysis of t-butyl chloride have been determined in a number of methanol-water mixtures, *viz.* 80 :20 (v/v), 75 :25 (v/v), 70 :30 (v/v), 65 :35 (v/v) at two temperatures, at 30° and 40°C. The kinetics have also been studied in the presence of added salts of both 'common' and 'non-common' ion types in two selected solvent compositions, viz. 80 :20 (v/v) and 75 :25 (v/v) at two temperatures 30° and 40°C. The Arrhenius parameters and the entropy of activation have been calculated.

The effect of solvent composition on the activation energy, and entropy of activation has been examined. It is found that although the specific rate increases as usual with the increase in the proportion of water in the solvent, the activation energy and the entropy of activation show trends opposite to those expected from the Hughes-Ingold theory of solvent effect. An attempt has been made to explain the anomaly from the stand point of the change in dielectric constant.

The effects of salts on the kinetics are found to be extremely irregular. The results show that they cannot be used as useful tools for distinguishing reaction mechanism of solvolytic reactions.

182. The influence of ultrasonic waves on the adsorption of acids by carbon.

A. K. GHOSH, Calcutta.

Varying quantities of formic acid, acetic acid and oxalic acid were mixed up with requisite amount of water to make the volume in each case to 20 ml. One gm. of carbon was then added to it. The quantity of carbon used were (a) Activated carbon (Pack and Roy), (b) Animal Charcoal (B.D.H.) and (c) Wood charcoal (E. Merck). The mixture was then exposed to ultrasonic waves of frequency 1 Mc/s and power 225 watts/sq. cm. for 30 mins. The content of the vessel was filtered and the liquid titrated for the unadsorbed hydrogen ion with standard alkali (NaOH). Another set of observation were taken with an exposure of 60 mins. The unexposed mixtures were shaken intermittently with hand and after intervals of 30 and 60 mins, the contents of the vessel were filtered and the solution estimated as above. The results show that the ultrasonic waves have neither retarding nor accelerating effect on the adsorption of acids.

183. A Kinetic Study in Furfural Polymerization.

NIRMALENDU DUTTA and P. K. CHOUDHURY, Calcutta.

A Kinetic study in furfural polymerization in presence of orthophosphoric acid (sp. gr. 1·75) was undertaken to determine the rate of polymerization of furfural. The experiment was carried out by treating furfural with orthophosphoric acid (100 gms. of furfural containing 15 gms. of orthophosphoric acid) in an atmosphere of nitrogen at 60±1°C and the amount of polymer formed was determined at regular intervals by the technique of fractional precipitaton in the following way. A known amount (about 2-3 gms.) of the polymerized product was dissolved in acetone and a suitable nonsolvent (water) was added dropwise to the solution to get the polymer precipitated. It was observed that the conversion of the monomeric furfural to its polymeric form was very small even after prolonged period of reaction (7·4% after 168 hrs. of reaction). It was also observed that the rate of the reaction was very slow in the beginning but towards the end it became very fast leading to gelation.

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184. Transport number of cadmium and iodide in aqueous solution of cadmium iodide by analytical boundary method.

D. MANGARAJ, S. ADITYA and B. PRASAD, Kharagpur.

The transporlt numbers of Cadmium and Iodide in aqueous solutions of Cadmium Iodide have been measured at 30°C over a concentration range from 0·02N to 0·5N by following cation and anion boundary respectively in Analytical Boundary experiments. The cadmium transport number increases from 0·398 to 0·438 as the concentration changes from 0·02N to 0·05N and then gradually decreases to a value of 0·124 at 0·5N. The Iodide transport number, increases gradually from 0·548 to 0·90 as the concentration changes from 0·02N to 0·4N. Transport number measurements using Hittorf's method have been undertaken at three concentrations at 30°C and the values so obtained compare favourably with the values obtained by anion boundary. The increase in Iodide transport number, decrease in Cadmium transport number and the discrepancies shown by cation boudary results have been satisfactorily explained on the basis of relative distributions of positively and negatively charged complexes at different concentrations of Cadmium Iodide and their effect on material transport number.

185. Butanolysis of Oils.

S. K. K. JATKAR and (Miss) M. V. NATEKAR, Poona.

Butanolysis of cocoanut, olive and castor oil has been studied in the presence of BuONa at 25° and 35°C. The velocity coefficients for these second-order autocatalytic reactions decreased in the order : cocoanut, castor and olive oil. The latter two oils were also butanolysed at 0°C.

186. Crystal growth studies on naphthalene.

R. M. MALLYA, Bangalore.

The influence of diffusion and mass transport on the growth form of naphthalene from vapour is presented. The two-dimensional nuclei formed on glass change over to surface dendrites. The influence of temperature and supersaturation on the growth forms of these crystals has been studied. The change of form from whiskers to platelets, dendritic crystals and foliated crystals has been studied.

187. Acetylacetone complexes of cadmium and lead—a polarographic study.

A. K. SUNDARAM, Bombay.

A polarographic study of cadmium and lead in acetylacetone medium has been carried out. The half-wave potentials are measured at different pH. From the shift in the half-wave potentials as a function of free acetylacetonate ion, the pH values from the cadmium and lead complexes have been calculated to be 6·12 and 6·32 respectively.

188. On the behaviour of lead in iodide medium at the dropping mercury electrode—II. an A. C. polarographic study.

A. K. SUNDARAM, Bombay.

An a.c. polarographic study of lead in the iodide medium has been carried out to confirm the observations by the conventional method on the irreversible

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nature of the waves obtained by the earlier workers. At low concentrations of lead, a single reversible wave and at moderate concentrations, an irreversible wave were observed but at fairly high concentrations, two d.c. waves were obtained. The second wave was attributed to the adsorption of the lead iodide complexes at the electrode. The results by the a.c. method generally confirm these observations. Corresponding to the d.c. waves, three peaks are obtained : the first peak due to the differential of the first step and the second and third peaks due to a combined tensammetric-polarographic process.

189. Infrared, near infrared and Raman Spectra of polyatomic molecules and its correlation with N.M.R. Spectra.

S. K. K. JATKAR, N. C. GUJRATHI and A. J. MUKHEDKAR, Poona.

Infrared, near infrared and Raman Spectra of methylene chloride, chloroform, methyl alcohol, ethyl alcohol, n. propyl alcohol, and butyl alcohol; ethylene dichloride and tetrachloroethane; benzene, toluene, nitrobenzene, aniline, mono chloro, bromo and iodo-benzene, o-dichlorobenzene; coumarin, pyridine, quinoline, isoquinoline, α picoline, thiophene, furan, and cyclohexane have been studied using DK_2 and IR_4 Beckman Spectrophotometers. The results show the remarkable correlationship between N.M.R. spectra on one hand and the infra, near infra and Raman spectra on the other. A further correlationship has been shown between the variations in the bond moments by the component law and the parallel relationship between the frequencies of C-H with C-C bonds.

190. Catalytic properties of some metallic sesquioxides.

K. S. DE, Kharagpur and Bristol, U.K.

Hydrogen-deuterium exchange reaction was studied over Ti_2O_3, V_2O_3, Cr_2O_3, La_2O_3, and In_2O_3. It was normally carried out in a static system using a hydrogen-deuterium mixture of ratio 3 : 1 between 0°C and 500°C and 1-2 cm. pressure. The course of the reaction was followed by withdrawing small amounts of the reactants at regular time intervals and analysing the samples in a mass spectrometer. Relative activities of the oxides have been compared from the rate constants and it has been shown that at lower temperatures Ti_2O_3 and V_2O_3 have comparable rates, while Cr_2O_3 possesses higher activity. Activation energies have also been derived for the first three oxides and it has been found that V_2O_3 has a higher activation energy (15·2 Kcal/mole) than titanium sesquioxide (6·1 Kcal/mole) and chromium sesquioxide. The oxides La_2O_3 and In_2O_3 have been found to be appreciably reduced under the experimental conditions.

The results as a whole are discussed within the context of activity patterns being related either to the extent of d-shell occupation or to semi-conductor type. For H_2—D_2 exchange on Ti_2O_3, V_2O_3, and Cr_2O_3, the results appear to support Dowden's view that the activity of the oxides is related to the number of unpaired d-electrons of the metal ion.

191. Studies in the reaction between lead nitrate and sodium nitrite : Magnetic Susceptibility and Faraday Rotation Measurements.

D. G. VARTAK and M. B. KABADI, Bombay.

The reaction between lead nitrate and sodium nitrite in acquous solution has been studied by measuring the magnetic susceptibilities and Faraday rotations of

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the different mixtures containing the reacting substances in various molar proportions. It has been concluded from the study that the two salts combine to form in solution a compound with the composition $Pb(NO_3)_2 . NaNO_2$.

192. The high pressure reaction between p. Dioxane, Carbon Monoxide and water.

T. VENUGOPALA CHARLU and M. R. A. RAO, Bangalore.

n-propionic acid has been found to be the primary product of the reaction between p-dioxane, carbon monoxide and water at high pressures. Not even a trace of succinic acid was detected in contrast to the results of J. W. Reppe. Small quantities of simple esters and liquid hydrocarbons were also found in the reaction product. The gaseous products contained considerable quantities of CO_2, unsaturated hydrocarbon—mainly ethylene—and saturated hydrocarbons. An optimum conversion of 42% of dioxane into propionic acid was obtained at a dioxane to water ratio of 1 :2, a maximum pressure of 4000 psi and a temperature of 270°C in the presence of 1 gm of iodine as catalyst. No acid was formed in the absence of the catalyst. Various other catalysts have also been tried. 1 gm of iodine was however found to be the best catalyst.

The reaction probably proceeds through the pyrolysis of dioxane to ethylene and the subsequent reaction of ethylene with carbon monoxide and water to form propionic acid.

193. An apparatus for the preparation of single crystals from the melt.

SUNIL K. DATTA, Calcutta.

An apparatus has been designed and locally constructed for the preparation of pure and doped single crystals from the melt. This involves gradual withdrawal of a single crystal seed dipped in the melt of the corresponding material, both being maintained at proper temperatures. A water-cooled pure nickel pulling shaft was used to raise the seed. A 1-rpm synchronous motor along with a clock-work gear system gave the desired speed reduction, the pulling rate being 5 to 20 mm/hr. A proper control of the temperature of the melt and the rate of flow of heat from the seed which are of critical importance in the initial stage of the growth was attained by adjusting the furnace temperature and water flow in the nickel shaft. An optical system was devised to observe the growth of the crystal during the experiment. Annealing was performed *in situ*, the crystal being detached from the seed and put over the solidified melt. Single crystal 'boules' of about 2 cm diameter and 1·5—2 cm length were grown by this method.

194. "Study of the system lanthanum—Mandelate".

P. L. KACHROO and ARUN K. BHATTACHARYA, Saugar.

The reaction between lanthanum chloride and mandelic acid has been studied by employing the electrical conductance data. A 1 :1 ratio is indicated by the monovariation method with two different compositions of both the solutions. This has been confirmed by the Job's method of continuous variation with two different compositions and in both the cases maxima are observed at the ratio 1 :1. The value of dissociation constant of the above complex has been found by the Job's method which comes to $2{\cdot}81 \times 10^{-3}$ at 26°C.

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195. Formation of Thallous Tartarate complex.

K. N. SAHU and ARUN K. BHATTACHARYA, Saugar.

A 2 :3 complex between thallous nitrate and tartaric acid has been found to exist in solution. This has been established by the monovariation method with both pH and electrical conductance measurements for different compositions of thallous nitrate and tartaric acid. This has been next confirmed by the Job's method of continuous variation using electrical conductance data for two different molarities of the two solutions.

The value of dissociation constant of the complex was determined by Job's method by employing conductivity data for four different sets. The average comes to $4{\cdot}606 \times 10^{-12}$ at 28°C.

196. "Formation of Thorium Sulphosalicylate complex".

D. D. SHARMA and ARUN K. BHATTACHARYA, Saugor.

Thorium (iv) has been found to form a 1 :1 complex with 5-sulphosalicylic acid. This has been first established by the monovariation method taking pH and electrical conductance as the physical properties. Job's method of continuous variation gives a further support to the 1 :1 complex from conductivity data used as an indicative property. Same results are obtained for different compositions of the two solutions.

The value of the dissociation constant of the thorium sulphosalicylate complex has been calculated by the Job's method with conductivity data. The average value comes to $3{\cdot}70 \times 10^{-3}$ at 28°C.

197. Physico-chemical study of precipitates by Job's continuous variation method". Part II: Precipitation of Cerous Tungstate.

M. C. SAXENA and A. K. BHATTACHARYA, Saugar.

The precipitation of cerous tungstate has been studied by means of monovariation as well as Job's continuous variation methods.

The investigation of the system by applying the monovariation method was done in two ways : (i) keeping the concentration of cerous chloride constant and varying that of sodium tungstate, and (ii) vice-versa. The pH and conductometric data revealed the formation of normal cerous tungstate, $Ce_2(WO_4)_3$.

Conductometric study of the system by applying the method of continuous variations at three equimolar concentrations of the reactants (M/30, M/40, and M/60) confirmed the above result. It appears that the method of continuous variations can be applied in studying the composition of insoluble substances.

198. "Physico-Chemical study of complex formation of sodium molybdate with organic ligands". Part I: With mandelic acid.

S. P. BANERJEE and ARUN K. BHATTACHARYA, Saugar.

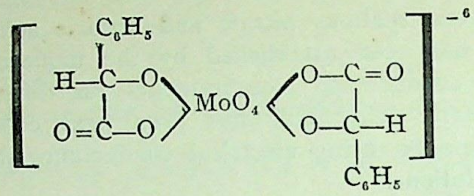
An electrometric study of the reaction between sodium molybdate and mandelic acid has been undertaken. pH and electrical conductance data show a 1 :2 complex between sodium molybdate and mandelic acid for different compositions of the two solutions. Job's method of continuous variation was then employed to confirm the stoichiometry by studying the conductivity of different sets of equimolar solutions of the two.

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The value of dissociation constant has been calculated by taking non-equimolar solutions which comes to $4{\cdot}82 \times 10^{-8}$ at 28°C from conductivity results.

The following structure of the molybdo-mandelate complex has been advanced :



199. "Studies in Chromium tellurate sol."

K. T. MANDLOI and ARUN K. BHATTACHARYA, Saugar.

Chromium tellurate sol was prepared by adding 0·5% potassium tellurate to about 13% solution of chromium chloride. The exact values were obtained by trial. It was found to give a transparent gel in ten days.

Various physical property values were measured during the course of dialysis. It was observed that electrical conductance, refractive index, pH and density values first decrease and as the dialysis progresses the values become constant. Surface tension values gradually increase, whereas viscosity values generally decrease.

200. "Study of para-amino salicylate complex of manganese (II) by conductometric and spectrophotometric measurements".

M. S. KACHHAWAHA and Arun K. BHATTACHARYA, Saugar.

Complex formation has been studied between manganese chloride and sodium p-amino salicylate. A 1 : 1 complex has been established by means of the Job's method of continuous variation employing conductometric and spectrophotometric data. Only one complex is found by studying the reaction at different wave lengths.

The value of dissociation constant for the complex was calculated by the Job's equation and was found to be $5{\cdot}7 \times 10^{-4}$. A possible structure for the complex was advanced based on theoretical and experimental results.

201. "Study of the hydrous cobalt oxide".

S. K. AWASTHY and ARUN K. BHATTACHARYA, Saugar.

When sodium hydroxide is added to a solution of cobalt nitrate the amount of alkali needed for complete precipitation of cobalthydrousoxide was found to be less than two equivalents. This was arrived at by examining the supernatant liquid obtained by centrifuging different samples containing varying amounts of the alkali. pH and conductometric data also support the above conclusion.

On ageing the value of conductance increases before the equivalence point while it decreases in presence of excess alkali. pH values go on decreasing with age till the equivalence point is attained, whereas it increases after the addition of more alkali.

202. Spectroscopic and magnetic properties of uranyl and uranous salts.

S. K. K. JATKAR, A. J. MUKHEDKAR, (Miss) R. M. KARNIK and A. V. KHEDEKAR, Poona.

Ultraviolet spectra and magnetic susceptibility of U(VI) in water, diethyl ether, ethyl acetate, acetone, methyl ethyl ketone, acetic acid, and in nitric, sulphuric

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and perchloric acids were determined. U(VI) was also studied in thiocyanate medium.

Magnetic properties of U(IV) complexes (solids) and their ultraviolet spectra in acid solutions were determined. For the magnetic measurements, Gouybalance and Curie-balance were assembled in the Department. U(IV) complexes were prepared by photolysis of the corresponding U(VI) complexes in different solvent mixtures.

The spectra and magnetic measurements of U(IV) complexes show two unpaired electrons in 5f level. However, U(IV) formate and acetate gave anomalous results; the complex formed after photolysis of U(VI) formate shows the formation of uranous-uranyl complex, as observed from the ultraviolet spectra and the magnetic susceptibility.

The spectra and magnetic properties of uranyl nitrate, sulphate, and acetate were determined in different organic and inorganic solvents mentioned above. It is observed that the nature of the ultraviolet spectra (band position, sharpness, and shape) goes hand in hand with the magnetic measurements. The environmental dependence of spectra and magnetic properties are explained in terms of ligand field theory.

Infrared spectra of uranyl nitrate and acetate crystallised from organic solvents were studied. It is observed that organic solvents form molecular complexes with UO_2++. However, these complexes are labile to pressure, temperature and moisture, reverting to the corresponding hydrates.

203. Infrared spectra of pyrone derivatives.

S. K. K. JATKAR, Miss P. TRAKROO, A. J. MUKHEDKAR, K. G. MARATHI, Poona.

Pyrone and its derivatives were prepared and infra-red spectra were determined. The presence of cannonical structure of γ-pyrone is reflected in the C-H frequency band at 3220 and 2987^{cm-1}. The bands at 1700-1600^{cm-1} were analysed for C=O and ring vibration. The band at 1640^{cm-1} is due to C=O.

The assignments of the ring vibrations are given. The band at 1186^{cm-1} for o-hydroxy chromone indicate the presence of hydrogen bonded C—O bond. Three strong bands in the C=O range (1730^{cm-1}, 1701^{cm-1}, 1672^{cm-1}) for 2-6 dihydroxy γ-pyrone indicate the presence of symmetrical tri-carbonyl structure; however strong band at 1212^{cm-1} (γ-OH) shows the presence of modified -OH group.

204. Study of infrared spectra and magnetic susceptibility of binary system.

S. K. K. JATKAR, A. J. MUKHEDKAR and V. S. JATKAR, Poona.

Magnetic susceptibility and infrared spectra of ketones, halogenated liquids and amines were studied in different solvents. It was observed that Kirkwood-Bauer-Magat equation correlating the solvent refractive index and relative change in infrared frequency does not hold good in the systems studied, it only holds good in non-polar solvents. Magnetic susceptibility deviates slightly, but remarkedly from linear relationship. The sign of curvature of the mole fraction-susceptibility curve and the sign and magnitude of relative frequency shift go hand in hand and are correlated to the local interactions.

205. Infrared and Raman Spectra of CX_4 molecules.

S. K. K. JATKAR and N. C. GUJRATHI, Poona.

In the present paper the authors have applied the postulate of inductive coupling by component law to CH_4, CH_3Cl, CH_2Cl_2 and $CHCl_3$ and CCl_4. The

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frequencies calculated on the basis of component law have been shown to agree well with the observed frequencies.

206. Conductivity of Electrolytes.

S. K. K. JATKAR and A. G. KULKARNI, Poona.

(I)

The authors have studied the conductivity of binary systems in aqueous solutions, using a specially constructed precision conductivity bridge. The following systems are studied.

$CuSO_4-(NH_4)_2SO_4$, $NiSO_4-(NH_4)_2SO_4$,
$CoSO_4-(NH_4)_2SO_4$, and $Cr_2(SO_4)_3-(NH_4)_2SO_4$.

Plots of $\triangle 1/R/\triangle$C.C. against composition show a large series of peaks at the Stoichiometric ratios, which have been explained on the basis of breaking down of the water structure.

(II)

The conclusion of Attenburg and Gunter (Z. Physik. Chem. 200, 158-61 (1952)) that the conductance of aq. $CuSO_4$ (0·02—0·3M) is unaffected in presence of uttrasonic wares has been confirmed.

ORGANIC

207. Possible Anthelmintic Agents. Part I.

A. B. SEN, S. K. GUPTA and A. SINGH, Lucknow.

It has been postulated that the grouping $-CO-CH=CH-$ is responsible for bactericidal activity in view of this being present in many antibiotics (Marrian et al., J. Chem. Soc., 1947, 1419). Recently, a number of benzylidine acetophenones containing this grouping have also been found to possess anthelmintic activity (Takayanagi, Ann. Rep. Tok. Coll. Pharm., 1954, *1*, 10-15).

A number of benzylidine acetophenones have therefore been prepared with a view to study their anthelmintic activity.

The compounds were prepared by condensing appropriate acetophenones with different aldehydes in 60% potassium hydroxide solution.

The compounds prepared are,—2-2′-5′-trihydroxy-BA*, 2-chloro-2′-5′-dihydroxy-BA, 2-2′-5′-trihydroxy-5-chloro-BA, 2′-4-5′-trihydroxy-BA, 2′-3-dihydroxy-5-tert.-butyl-BA, 2′-hydroxy-2-chloro-5′-tert. butyl-BA, 2-2′-dihydroxy-3-methoxy-5′-tert. butyl-BA (BA* =benzylidine acetophenone).

208. Possible Antiamoebic Agents. Part XVII.

A. B. SEN and S. K. GUPTA, Lucknow.

It has been reported in a recent patent that 4 :6-disubstituted-2-amino-s-triazines possess antiamoebic activity (Brit. Pat. No. 708256).

Therefore, a number of similarly substituted s-triazines have been prepared by condensing various nitriles with amidines, with a view to testing their amoebicidal activity.

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The following compounds have so far been prepared—4 :6-diphenyl-2-amino-s-triazine, 4 : 6-di-(o-toluyl)-2-amino-s-triazine, 4 :6-di-(m-toluyl)-2-amino-s-triazine and 4 :6-di-(B-naphthyl)-2-amino-s-triazine.

Further work is under progress.

209. Photo-chemical formations of Amino acids in mixtures containing different sources of carbon in presence of Nickel as catalyst.

KRISHNA BAHADUR and RAJENDRA BAHADUR SRIVASTAVA, Allahabad.

The formation of amino acids in the prebiological era was the first step in Biopoesis and the possibilities of its synthesis under natural conditions have been greatly sought. Bahadur in 1954(1) demonstrated the photo-synthesis of amino acids in sterilised mixtures of paraformaldehyde, water and ferric chloride when the mixture is exposed to artificial or sunlight.

After the formation of organic compounds which might have been synthesised by irradiation as suggested by Baly(2) or by atomic radiations as proposed by Calvin(3) or which were initially present on the surface of the earth if the cold origin of Earth by Levin(4) is taken to be true, the possibility of formation of amino acids by even visible irradiations from the sun is much more probable then the formation of the amino acids by electric discharge in the atmosphere when in the remote prebiological era, earth atmosphere contained carbon monoxide, ammonia, hydrogen and methane as suggested by Miller(5). The photo-synthesis of amino acids in water containing organic carbon and mineral catalyst in pre-biological era can explain the initiation of the chemico-physical processes leading to the formation of origin of life in an atmosphere which was very much similar to the present one.

Photo-synthesis of amino acids in sterilised aqueous mixtures containing nickel ions as catalyst and different organic compounds as the source of carbon has been studied and it has been observed that tartaric acid, citric acid, adipic acid, benzoic acid, salicylic acid and glucose are good sources of carbon in the photosynthesis of amino acids. However, the photosynthesis of amino acids is much less if sorbitol or succinic acid is used as the source of carbon in these experiments. The most interesting thing is that though the nature of aminoacids synthesised changes a little with the source of carbon compounds, with many organic compounds similar amino acids are formed. Moreover, mostly natural amino acids are formed in these mixtures. This may explain the biopoesis of only a few natural amind acids constituting the whole range of native proteins.

References

1. Bahadur, K. Nature, 173-1131, 1954.
2. Baly, Stephan and Hood., Proc. Roy. Soc. London, 110-212, 1927.
3. Calvin, M, et al—Science, 114-416, 1951.
4. Bevin, B. Yu—"International symposium on origin of life on Earth" held in Moscow, 1957. Pregamon Press, London.
5. Miller, S. L., ibid., pp. 123-135 (1959).

210. Infra-red spectra and crystallinity.

T. K. K. SRINIVASAN, C. I. JOSE and A. B. BISWAS, Poona.

The infra-red spectra of Glycol mono-alkyl ethers in crystalline, liquid and in solution states are reported. The spectra indicates a splitting of the CH_2 rocking mode of vibration at 720 cm^{-1} and of the C-O-C stretching vibration at 1120 ± 2 cm^{-1} in the crystalline state. From a study of the temperature effect on the position of

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the bands at 893 cm^{-1} and 864 cm^{-1}, it has been shown that the ($O\text{-}CH_2\text{-}CH_2\text{-}O$) group exists in both the gauche and trans-configuration in the crystalline state.

211. Influences of structural changes on absorption in merocyanines (n=0).

B. K. SABATA and M. K. ROUT, Cuttack.

The present work describes the preparation of some merocyanines (n=0) derived from benzothiazole and quinoline as variable basic nuclei and rhodanine, pyrazolone, thiohydantoin, thiobarbituric acid and isooxazolone as variable acidic nuclei. Their absorption maxima have been determined, and the corresponding deviations calculated from the absorption data. As the deviation factor is a measure of relative basicity and acidity, the relative basicities and acidities of the nuclei used in the preparation of the above merocyanines have been evaluated from the deviation data. As no oxonol of the acidic nuclei, corresponding to the symmetrical methin cyanine (n=0) which is necessary for the calculation of deviation exists, the absorption maximum of the appropriate oxonol has been assumed to be at a hypothetical value about 100 mμ less than that of the monomethin oxonol.

212. Chemical examination of Mundulea suberosa Benth. Part III. Isolation of Mundulone.

A. C. GHOSH and N. L. DUTTA, Poona.

The detailed chromatographic examination of the ether extractive of the root bark of Mundulea suberosa has yielded a number of crystalline compounds including Munetone [J. Ind. Chem. Soc., 1956, *33*, 716; 1959, *36*, 165]. The present paper reports the isolation of a compound, m.p. 179-80° in 0·35% yield, which has been found to be identical with Mundulone [Proc. Chem. Coc. 1959, 150], an isoflavone of novel complexity, obtained from the African variety of Mundulea sericea.

213. Studies in the preparation of Blood Plasma Extenders, Part I: Partial Hydrolytic depolymerisation and fractionation of polysaccharides obtained from local strains.

A. N. DEY, Delhi.

Crude dextran prepared in the laboratories of the National Sugar Institute obtained from local strains of bacterias has been utilised in the present experiments. The crude material has been depolymerised by sulphuric acid, the hydrolysed product fractionated with the help of acetone in different lots and the portion rich in polysaccharides with 1,6-linkages and appropriate molecular weight have been separated and further processed to give materials conforming to the required properties for the clinical type of dextran.

214. Solution polymerisation of ethyl acrylate.

S. B. RATH, S. K. PATRA and D. MANGARAJ, Kharagpur.

The polymerisation of ethyl acrylate was undertaken to study the effect of alcoholic chain length on the different rate constants. Bulk polymerisation at 50°C, using Azo-iso-butyro-nitrile catalyst was found to be accompanied by autoacceleration and gel formation. Hence polymerisation was done in ethyl acetate, using

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different ratios of monomer and solvent. The rate was followed using a modified capillary dilatometer. It was found to be proportional to the first power of monomer concentration. Using a value of 0·092/minute for K and 31·2 K. Cal mole as activation energy for this catalyst, K_d at 50°C was calculated. Substituting this value in rate equation K/K_t-values were calculated. The mean values $(2{\cdot}77 \pm 0{\cdot}5) \times 10^6$ so obtained compare badly with such values for methyl and butyl acrylate (0·202 and 0·17 respectively). Polymerisation of methyl acrylate in 60% ethyl acetate was undertaken as a check. A value of 0·0895 was obtained for $K_p/K_t^{\frac{1}{2}}$, which compares favourably with literature data. Further work is in progress to check the anomalous results obtained for ethyl acrylate.

215. A note on "A new method for characterisation and estimation of oils and fats."

R. C. TRIPATHY, Puri.

Choudhury and Das Gupta (J. Ind. Chem. Soc. 1931, *8*, 423) have developed a new method for characterisation of oils and fats and estimation of adulteration on the basis of the temperature of evolution of CO_2 and the weight of CO_2 evolved on oxidation with $KMnO_4$. The method, however, has not been found to give reproducible results and the relation between the acid value and the temperature of CO_2 evolution and the quantity of CO_2 evolved as reported by them has not been always found to be correct. The experimental data obtained in the present work are given in the original paper.

216. Search for new antimalarials: Part VIII. Synthesis of Some 1:5-Diarylbiguanides.

A. B. SEN and P. R. SINGH, Lucknow.

In view of the observed antimalarial activity in certain 1 :5-diarylbiguanides (Neelakantan, J. Org. Chem., 1957, 22, 1587), twenty symmetrically substituted 1 :5-diarylbiguanide-hydrochlorides have been prepared by reacting metanilic acid, naphthionic acid, 3-hydroxynaphthionic acid, sulfanilamide, p-aminobenzoic acid, p-aminosalicylic acid, p-aminophenol, m-chloroaniline, p-bromoaniline, p-iodoaniline, 2 :4-dichloroaniline, 3 :5-dibromo-4-hydroxyaniline, 3-chloro-4-bromoaniline, 2-methyl-4-iodoaniline, p-anisidine, p-phenitidine, 6-aminobenzamide, ethyl-p-aminobenzoate, p-aminoacetophenone and p-aminoacetanilide with dicyanimide (prepared by the interaction of calcium cyanamide with aqueous cyanogen bromide) in aqueous medium in presence of hydrochloric acid at reflux temperature, with the object of studying the structure activity-relationship. The biguanides have been characterised through their picrates.

217. Alkaloids of Rhazya stricta Decaisne— Rhazinine.

N. ADITYACHAUDHURY and C. R. GHOSHAL, Calcutta.

In a previous communication (A. Chatterjee *et al., Chem. & Ind.,* 1034, 1961) the isolation and some of the properties of four crystalline alkaloids, mps. (i) 141°, (ii) 234-36°, (iii) 285-6°, and (iv) 115-16° (yield, 0·06, 0·015, 0·001, 0·0061 respectively) occurring in the leaves and roots of *Rhazya stricta* Decaisne (Fam : *Apocynaceae*) were reported. The results of a preliminary investigation of one of the two minor bases, m.p. 285-6° (dec.) are described in the present communication. From physical and other data, this alkaloid appears to be new and is designated as rhazinine.

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Rhazinine analyses well for $C_{21}H_{26}N_2O_3$, $2H_2O$ (methanol : ethylacetate : :1 :9) and has been separated from its congeners by chromatographic resolution over Brockmann alumina (methanol : chloroform : : 2 :8) ; R_f, 0·86 (n-butanol :formic acid : water : :12 :1 :7). Rhazinine forms a hydrochloride, m.p. 282-4° (dec.). The base itself is neutral but the hydrochloride is acidic in protonic solvents. Rhazinine exhibits a number of colour reactions strikingly similar to those of nerifoline (A. Chatterjee *et al., Sci. & Cult., 26,* 238, 1960), an alkaloid from *Alstonia neriifolia* (Fam : *Apocynaceae*). It shows selective absorption in the U.V. region : λ_{EtOH}^{max} 235 (log ε, 3·95) and 297 mμ (log 3·62) characteristic of quaternary alkaloid having $N_{(a)}$-C-$N_{(b)}$ system. The I.R. spectrum is also comparable to that of nerifoline (*loc. cit.*). Structure elucidation of rhazinine is underway.

218. Ind-N-methylation and O-methylation of Wieland-Gumlich Aldehyde, a degradation product of Strychnine.

(Mrs.) A. CHATTERJEE, (Miss) A. DEB and (Miss) B. CHAUDHURY, Calcutta.

Wieland-Gumlich aldehyde, $C_{19}H_{22}N_2O_2$, m.p. 213° (dec), has been synthesised according to the method of Anet and Robinson (*J. Chem. Soc.*, 1955, 2253) with some modifications.

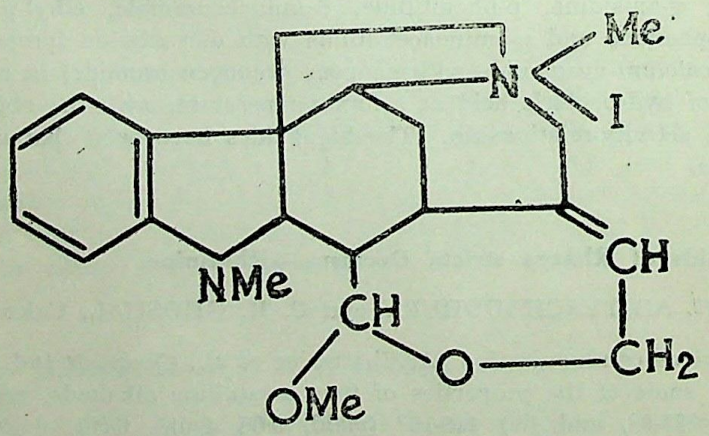
Its methiodide, $C_{20}H_{25}N_2O_2I$, m.p. 310° (dec), was prepared in the usual way and this on treatment with dimethyl sulphate and alkali (Philipsborn, Meyer, Schmid and Karrer, *Helv. Chim. Acta.*, 1958, 1257) gave Ind-N-methyl-o-methyl-N (b) methohydroxide of Wieland-Gumlich aldehyde.

The latter was carefully neutralised with hydroiodic acid and on evaporation in vacuum (10 mm/50°) furnished Ind-N-methyl-o-methyl-Wieland-Gumlich aldehyde-$N_{(b)}$ methiodide(I) along with sodium iodide.

The methiodide was purified by several crystallisations from dry acetone and absolute methanol from which it separated in light, shining, colourless flakes, m.p. 270-71° (dec).

It seems relevant to mention in this connection that during the preparation of Wieland-Gumlich aldehyde an appreciable amount of αα-dichloro methochloride of Wieland-Gumlich aldehyde, $C_{20}H_{23}Cl_3N_2O_2$, $2H_2O$, (does not melt but decomposes above 200°), was formed which confirmed the observations of Smith and Edwards (*J. Chem. Soc.*, 1961, 152).

So, chloroform was replaced by ether during the preparation of Wieland-Gumlich aldehyde for good yield.



(I)

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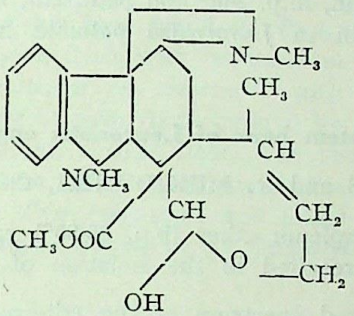
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219. Occurrence of an Allylamine system in Kopsine.

(MRS.) A. CHATTERJEE, (MISS) B. CHAUDHURY and (MISS) A. DEB, Calcutta.

Definite evidence for an allylamine system occurring in Kopsine, $C_{22}H_{26}N_2O_4$, m.p. 218° (dec), $[\alpha]_D^{25°}$ +16·35° (alcohol), an indoline alkaloid of *Kopsia pruniformis* Blume (Apocynaceae) has been provided. Kopsine methiodide, $C_{23}H_{29}N_2O_4I$, m.p. 200° (dec), on Emde degradation in presence 0·05 N alkali furnished a tertiary base (I), m.p. 210° (dec), which retained all the functional groupings but developed a terminal methyl group which is absent in the parent alkaloid.

This reaction is typical of an allylamine system as shown by Karrer, Schmid & Bickel (*Helv. Chim. Acta,* 1955, 649).



(I)

220. Trinitrobenzene Adducts of Indole and its Derivatives.

(MRS.) A. CHATTERJEE and (MISS) B. CHAUDHURY, Calcutta.

Redemann, Weller and Sell (Redemann, Wittwer and Sell, *J. Amer. Chem. Soc.,* 1951, *73,* 2957; Weller, Rebstock and Sell, *J. Amer. Chem. Soc.,* 1952, *74,* 2690) have developed a method for characterising indole compounds as their 1, 3, 5-trinitrobenzene adducts. This method has been extended by the present authors in characterising indole derivatives produced during the degradation experiments of indole alkaloids. 1,3,5-Trinitrobenzene adducts of indole, 2-methylindole and indole-2-carboxylic acid have been prepared in this connection and their m.ps. and other physical properties are given in Table I.

TABLE I.

Trinitrobenzene derivative of	M.P.	Colour	Crystalline Form.	Solubility in alcohol.
Indole ...	188-89°	Orange	Fine needles	Sparingly soluble in cold but soluble in hot state.
2-Methyl indole ...	183-84°	Brick red	Flakes	Moderately soluble in cold and hot state.
Indole-2-carboxylic Acid.	115-16°	Yellow	Needles	Moderately soluble in cold and hot state.

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221. Columbin, the bitter principle of Tinospora cordifolia Miers.

S. GHOSH and (MRS.) A. CHATTERJEE, Calcutta.

Tinosporine, the furanoid bitter principle of *Tinospora cordifolia* Miers (Fam. *Menispermaceae*) popularly known as "Nimgulancha" was assigned the molecular formula, $C_{20}H_{22}O_6$ or $C_{21}H_{24}O_7$ (A. Chatterjee and S. Ghosh, *Sci. and Cult., 26,* 141, 1960). Its acetylation with acetic anhydride-pyridine was unsuccessful. But on treatment with acetic anhydride-sodium acetate it afforded an acetate, m.p. 220-22° (dec.). The physical and chemical properties of tinosporine and its degradative studies suggested the identity of tinosporine with columbin, the bitter principle of *Jatrorrhiza palmata* Miers (D.H.R. Barton and D. Elad, *J. Chem. Soc.*, 2065, 2090, 1956) belonging to the same botanical family *Menispermaceae*. Their identity could subsequently be established from an examination of their (a) proton magnetic resonance spectra and (b) X-ray diffraction patterns.

Occurrence of chasmanthin, m.p. 246° and palmarin, m.p. 256-60°, the companion bitter principles of columbin in *Jatrorrhiza palmata* has also been observed in *Tinospora cordifolia.*

222. Triterpene from the stem bark of Leuconotis eugenifolia.

B. DAS and R. MUKHERJEE, Calcutta.

Investigation of the petroleum ether (b.p. 60-80°) extract of the stem bark of *Leuconotis eugenifolia* has resulted in the isolation of a triterpene, m.p. 179-80 , $[\alpha]_D^{30°}$ +73° ($CHCl_3$). Infra-red spectrum of the triterpene shows the presence of hydroxyl band at 3·1 μ. It forms a monoacetate, m.p. 225°, $[\alpha]_D^{30°}$ +68° ($CHCl_3$) and a monobenzoate, m.p. 220°, $[\alpha]_D^{30°}$ +93° ($CHCl_3$). Analytical results of the triterpene, its acetate and benzoate are in agreement with the molecular formula $C_{30}H_{50}O$. The acetate forms yellow colour with tetranitromethane indicating the presence of a double bond in the compound. Further investigation for the elucidation of the structure of the triterpene is in progress.

223. Mercurated Dyes, Part IV : Preparation of some mercurated Azo dyes.

V. N. NIGAM, H. L. ROHATGI and A. N. DEY, Kanpur.

The present paper deals with the preparation of some azo dyes obtained by the condensation of O-chloromercuri-p-cresol and monomercurated -α-naphthol with the diazotised bases, viz. 2-methoxy-4-nitroaniline, 2-methoxy-5-nitro-aniline, 2-nitro-4-methyl aniline, o,m,p-nitro anilines, o- and p-toluidines, 5-chloro-2-methyl aniline, and 2-methyl-4-chloro aniline. The mercury atom in these compounds is attached to the part of the dye molecule which has been formed out of the phenol or naphthol utilised in the reaction. The dyeing property of these compounds both for cotton and wool has been examined. Their suitability as rot and mildew proofing agent for textile materials has been also studied. Some of them show good promise for use as a direct dye for wool and also as rot and mildew proofing agent.

224. Chemical Examination of Shorea Robusta : Part I. Isolation of Leucoanthocyanidin.

C. BHEEMASANKAR RAO and V. VENKATESWARLU, Waltair.

Chemical examination of Shorea robusta resulted in the isolation of four chemical constituents : a neutral compound, m.p. 90-92°, two triterpenes m.p. 304-6° and

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327-29° and a leucoanthocyannidin, m.p. 280°, having the molecular formula $C_{15}H_{14}O_7$, $2H_2O$. It formed a hexaacetate, a tetramethyl ether and a diacetate of the methyl ether. Boiling with dilute hydrochloric acid gave cyanidin chloride. Oxidation of the methyl ether with potassium permanganate gave veratric acid while with sodium meta periodate, veratric aldehyde and di-o-methylphloroglucinaldehyde were obtained. From these considerations, the leucoanthocyanidin is identified as (+)-5,7,3′,4′-tetrahydroxyflavan-3,4-diol. The nature of the other constituents is still under investigation.

225. Bomination at allylic carbon atom : Uses of Pyridine-bromine complex.

D. M. PATKI and M. G. MARATHEY, Amravati.

Pyridine-bromine complex has been found to effect substitution analogous to N-bromosuccinimide. Present work deals with bromination at the allylic carbon atom. 4-Methyl-7-hydroxy-8-allyl coumarin on treatment with pyridine-bromine complex gives a bromocompound identical with that obtained by the action of NBS indicating the bromination at the allylic carbon atom. The bromocompound on treatment with sodium hydroxide solution gives a compound free from bromine and giving no colouration with $FeCl_3$. This compound was found to be different from 7 : 8 dihydro furano and 7 : 8 furano derivative of 4-methyl-7-hydroxycoumarin.

226. Chemical examination of Vetiver Oil (Bharatpur) isolation and characterisation of a new Sesquiterpene Alcohol, Khusinol.

(Mrs.) A. A. RAO, K. K. CHAKRAVARTI and S. C. BHATTACHARYYA, Poona.

A systematic chemical examination of Bharatpur variety of vetiver oil (*Vetiveria zizanioides*) has been undertaken. By subjecting the oil to elaborate column chromatography on neutral alumina two crystalline sesquiterpenic alcohols have been isolated along with other products. Alcohol (m.p. 86-87°, $[\alpha]_D^{26°}$ −174°4) have been named khusinol. On the basis of U.V., I.R. and degradative experiments, khusinol has been assigned a cadalenic structure with two double bonds, one of which is methylenic and the other trisubstituted. The latter is allylic to the secondary alcoholic group present in it. The other alcohol (m.p. 101-102°) is identical with khusol.

227. Isoquinoline Derivatives : Part XII—Potential Antispasmodics related to Papaverine and Atropine.

BINAY KUMAR GHOSH and T. N. GHOSH, Calcutta.

Methyl 1, 3-dimethyl-3, 4-dihydro-3-*iso*quinolyl ketone has been prepared and its oxime has been reduced to 1, 3-dimethyl-3-α-aminoethyl-1, 2, 3, 4-tetrahydro*iso*quinoline. β-Diethyl-aminoethyl 1, 3-dimethyl-3, 4-dihydro*iso*quinoline-3-carboxylate and the corresponding 1-benzyl analogue have been synthesised. 1-Chloromethyl-3-methyl*iso*quinoline has been prepared and condensed with some primary and secondary amines. Phenylacetic acid ester and β-phenylpropionic acid ester of 3-methyl-*iso*quinolyl-1-carbinol have been prepared. Some of these compounds embrace the structural features of both papaverine and atropine in the same molecule.

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228. Isonicotinyl Hydrazones as potential Antitubercular Agents.

T. N. GHOSH and U. P. BASU, Calcutta.

Recently the British Medical Research Council has made an interesting observation (*cf. Tubercle,* 1960, *41,* 399), based on a controlled trial, that a combination of isoniazid (200 mg.) with thiacetazone (150 mg.) offers some definite advantages in the treatment of tuberculosis. This observation has stimulated the preparation of *p*-acetylaminobenzaldehyde isonicotinyl hydrazone. This hydrazone is claimed to have been prepared by Russian as well as American workers but there is discrepancy in the melting point, as recorded by them. This hydrazone has now been prepared by reacting *p*-aminobenzaldehyde with isoniazid and subsequent acetylation of the resulting product. Thus prepared, the compound melts at 287-288° and its ultraviolet spectrum $\left\{ \begin{matrix} (0{\cdot}1N)\ NaOH\ 330\ m\mu\ (\log \varepsilon 4{\cdot}33) \\ \lambda\ max. \end{matrix} \right\}$, which is found to be similar to that $\left\{ \begin{matrix} (0{\cdot}1N)\ NaOH\ 330\ m\mu\ (\log\ \varepsilon\ 4{\cdot}48) \\ \lambda\ max. \end{matrix} \right\}$ of thiacetazone, points to the purity of the compound.

229. Isoquinoline Derivatives as possible Amoebacides. Part IV.

SUNIL KUMAR GANGULY and T. N. GHOSH, Calcutta.

N-β-Phenethyl-cyanoacetamide has been cyclised with phosphorus pentoxide to furnish 1-cyanomethyl-3-, 4-dihydro-*iso*quinoline. The latter has been reduced with sodium and ethanol to yield 1-(β-aminoethyl)-1, 2, 3, 4-tetrahydro*iso*quinoline. Some alkyl- and arylmalondi-α-alkyl (or aryl)-β-phenethylamides have been prepared and cyclised with phosphorus pentoxide in boiling toluene to yield the corresponding 1,1′-alkyl (or aryl)-methylene-*bis*-3-alkyl (or aryl)-3, 4-dihydro*iso*quinolines, which could be dehydrogenated over Pd-C in tetralin at 240° to the corresponding fully aromatised *iso*quinolines.

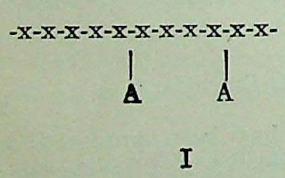
230. Methylation studies of Araboxylan isolated from the Pea-skins (Pisum-Sativum).

C. V. N. RAO and N. BANERJI, Calcutta-32.

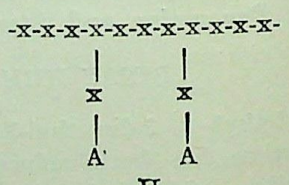
The completely methylated polysaccharide gave on hydrolysis, 2, 3, 5-tri-O-methyl Arabinose, 2,3-di-O-methyl Xylose, 2-O-methyl Xylose and traces of D-xylose and 2, 3, 4-tri-O-methyl Xylose.

The ratio of different methylated sugars was found to be : trimethyl Arabinose : dimethyl-Xylose : mono-methyl Xylose = 1 : 4·4 : 1·1.

On the basis of the methylation results two probable structures (I and II) may be put forward for the repeating unit of the polysaccharide :



I



II

Structure I was found to be correct as, on mild hydrolysis, L-arabinose was removed leaving a Xylan chain with very few arabinose units attached to the main chain. Periodate-oxidation studies on both the original and degraded polysaccharides and estimation of sugar residues unattacked by periodate lead to the confirmation of the structure I.

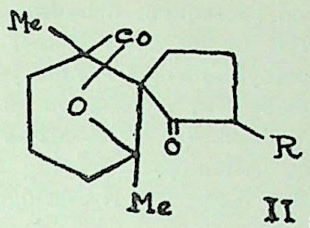
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231. An unusual Ring-Closure with Polyphosphoric Acid.

P. C. DUTTA, S. L. MUKHERJEE and (MISS) D. MUKHERJEE, Calcutta.

The present investigation deals with experiments leading to the synthesis of the keto-lactone (III) incorporating a cyclopentanone ring as a result of an unusual type of ring-closure, during the attempted synthesis of an important degradation product of marrubiin (I).



II , R = H

III , R = CH_3

An unambiguous synthesis of 3-methyl-3-carboxy-2-(γ-carboxypropyl)-cyclohexanone, m.p. 161°, was carried out in this laboratory which was subsequently utilized in the present investigation. The above acid was esterified to the corresponding di-ester which was allowed to react with methylmagnesium-iodide. The Grignard's reaction product was dehydrated to afford 1 :3-dimethyl-3-carbethoxy-2-(γ-carbethoxypropyl)-Δ^1-cyclohexene. It was then subjected to partial hydrolysis and subsequent cyclisation of the acidic material furnished 3-hydroxy-1 : 3-dimethyl-2-(γ-carboxypropyl)-cyclohexane-1-carboxylic lactone in the acidic fractions and the keto-lactone (II; m.p. 159-160°) in the neutral fractions along with γ-(2-hydroxy-1 :3-dimethyl-1-carbethoxy-cyclohexyl-2-)-butyric acid lactone.

The keto-lactone (II) was methylated at the α-position to the carbonyl function through formylation, acetylations and catalytic reductions. The methylated keto-lactone (III; m.p. 128-129°) showed bands at 5·65 μ (s); 5·76 μ (m) in infra-red. Experiments are being conducted to study similar systems to evaluate the steric influence of the groups in directing this type of ring-closure.

232. Synthetic Studies in Terpenoids.

S. K. MUKHERJEE, C. T. MATHEWS, (MRS.) C. DUTTA and (MISS) G. SEN GUPTA, Calcutta.

In the course of total synthesis of bicyclic diterpenoids the preparation of 6 :6-Ethylenedioxy-1 :1 :10-β- trimethyl- Δ^8-octal-2-one (I) (Narang and Dutta, J.C.S., 1960, 2842) has been considerably improved by using Mannich base method. The decalone (I) was purified by chromatography over alumina and eluted with petroleum ether (40-60°C). This was reduced by Wolf-Kishner method to form an oil which was deketalised with acetone in presence of p-toluene sulphonic acid. This on catalytic reduction in presence of platinum oxide afforded an oil b.p. 100°C/0·5 mm. which was further characterised through a semicarbazone, m.p. 220-222°C. Further investigations are in progress to build up the aliphatic C_6-chain present in the resin-acids at the proper position of the decalone.

233. Synthetic Investigations in Diterpene Alkaloids.

H. S. SURI, A. K. KUNDU, O. S. BHANOT and A. BANERJEE, Calcutta.

Recently exhaustive works were carried out in the structural elucidation of Garrya-type alkaloids of diterpene group (Weisner *et al*, Chem. & Ind., 1957, 173;

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Anet *et al*, Canad. J. Chem., 1957, *35*, 397). Stereospecific synthetic projects have been undertaken in this laboratory to synthesise these type of alkaloids. The present communication describes the synthetic investigations of a model compound having the heterocyclic ring related to the diterpene alkaloids.

Potassium cyanide was added to 3-methyl-cyclohexanone and the resulting product afforded 1-methyl-1-cyano-cyclo-hexan-3-one (I) along with a dicyano-compound. The dicyano-compound on hydrogenation and hydrolysis furnished 1-methyl-1, 3-dicarboxycyclohexane. The compound (I) was subjected to Reformatsky's reactions with bromo-acetic ester and on subsequent dehydration yielded 1-carbethoxy methyl-3-methyl-3-cyanocyclohexane (II) or its bond isomer which was then catalytically reduced to 1-carbethoxymethyl-3-methyl-3-cyanocyclohexane (III). The cyclopentanone ring was next developed by cyclisation of the cyano-ester (III) and the resulting bicyclic-ketone (IV) afforded a colourless liquid (b.p. 95-96°/24 mm.) having a camphoraceous odour. Attempts are being made to rearrange the oxime of the bicyclic ketone (IV) to the desired -C-N-C-bridge present in A/B rings of these alkaloids.

234. Preparation of Anilino Malonates.

P. N. MOZA and B. G. CHATTERJEE, Kharagpur.

The conventional method for the condensation of anilines and bromomalonate has been modified to afford the high yields of the corresponding anilino malonates in shorter period. The reactions were carried out without a solvent at 50—60°C at a slightly reduced pressure (40—50 mm.) when the yields obtained were 95%.

235. Paper electrophoretic studies on some Coumarins.

J. DUTTA and B. K. BURMAN, Calcutta.

The coumarins in general dissolve in alkaline solution due to the opening of the lactone ring followed by ionic dissociation. With this picture in view the electrophoretic behaviour of some of the coumarins was studied by means of paper electrophoresis technique. The coumarins used in these studies were coumarin, psoralene, umbelliferone, dalbergin, marmesin and wedelolactone. The alcoholic solutions of the samples were applied at the centre of 40cm × 6cm Whatman No. 1 filter paper strips. The strips were then sandwitched between two glass plates and electrophoresis was carried for about an hour with an applied potential gradient of 10 volts/cm.

The electrolytes used were (1) N/10 NaOH solution and (2) Glycine-NaCl-NaOH buffer system of varying pH.

The results obtained are presented in the following table.

Coumarins	Mobility (cm^2/volt × hour)		
	N/10 NaOH solution	Glycine buffer pH 12·7	Glycine buffer pH 8·45
1. Coumarin	−0·90	−0·90	−0·05
2. Psoralene	−0·24	−0·76	0·00
3. Umbelliferone	−0·33	−0·43	−0·33
4. Dalbergin	−0·10	−0·18	0·00
5. Marmesin	−0·15	−0·40	+0·20
6. Wedelolactone	−0·12	0·00	0·00

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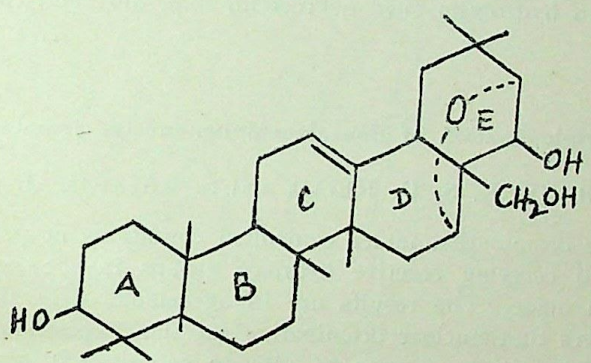
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236. Triterpenoids XII. The Constitution of Barringtogenol D.

SACHINDRA K. CHAKRABORTI and A. K. BARUA, Calcutta-9.

The isolation of Barringtogenol D, a new triterpenoid sapogenol, $C_{30}H_{48}O_4$, m.p. 305-10°, from the fruits of *Barringtonia acutangula* Gaertn has been reported earlier (Barua, Maiti and Chakraborti, *J. Pharm. Sciences, 50,* 1961, in press). This paper describes the structure and stereochemistry of barringtogenol D.

Three of the oxygen atoms of barringtogenol D are present as three alcoholic groups and the fourth oxygen atom occurs as an internal oxide function. Barringtogenol D belongs to the β-amyrin group of triterpenes and the ethylenic linkage present in it shows anomalous behaviour due to the presence of the oxide linkage. From the various oxidative and other reactions and the close similarity of certain behaviours with aescigenin, the structure of barringtogenol D has been assigned as 3β-22β-28-trihydroxy-$\triangle^{12}$-16α-21α-oxido oleanen (I). This structure has been confirmed by converting barringtogenol D into a deoxy compound, $C_{30}H_{48}O_2$, m.p. 198-200°, which forms an acetate, $C_{32}H_{50}O_3$, m.p. 201-03°. The identity of these compounds with 22β-hydroxy-$\triangle^{12}$-16α-21α-oxido-oleanen and its acetate respectively Cainelli, Melera, Arigoni and Jeger, *Helv. Chim. Acta, 40,* 2340, 1957), coupled with the chemistry of barringtogenol D finally establishes its structure and stereochemistry as (I).



(I)

237. Isolation and study of a Ketolactone from the bark of Feronia elephantum.

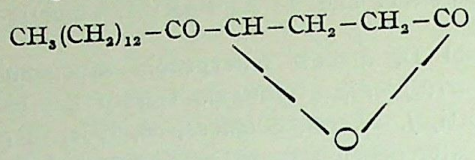
R. D. TEWARI and J. P. TEWARI, Allahabad.

From the stem bark of the plant Feronia elephantum a compound $C_{18}H_{32}O_9$ (m.p. 115°C), has been obtained by extraction with ethanol. The compound gives all the tests of a ketone, forms a 2 :4 dinitrophenylhydrazone and gives peaks at 1136 cm.$^{-1}$ and 1479 cm.$^{-1}$ in the I.R. spectra. It has been found to dissolve in hot sodium hydroxide and on acidification of the solution the original compound is precipitated back. It gives a characteristic peak at 1754 cm.$^{-1}$ for a lactone. The reaction with HBr, HI and esterification with methanol forming ester of an hydroxy acid, all show the presence of a lactone structure. On oxidation with nitric acid it forms a fatty acid $C_{14}H_{28}O_2$ which has been found to be myristic acid

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and the other acid left in the aqueous solution has been identified to be succinic acid. The compound appears to be lactone of the formula



Experiments for the confirmation of this structure are in progress.

238. Chemical examination of the berries of Solanum nigrum Linn.

S. S. NIGAM and G. C. JAIN, Saugor, M.P.

The glyceride structure of the fixed oil from the dried berries has shown the presence of disaturated oleins 3%; saturated oleo linoleins 6%; di-oleolinoleins 46%, and oleodi-linoleins 45%. Two hydrocarbons, pentetriacontane, and tricontane and two sterols β-sitosterol and dihydrosterol have been isolated from the unsaponifiable matter of the oil.

The defatted berries yield a steroidal saponin $C_{45}H_{84}O_{22}$, m.p. 220° (decomp.), which on hydrolysis gives a sapogenin, $C_{27}H_{48}O_4$, m.p. 198-199°, and three sugars, rhamnose, glucose, and galactose.

The glucoalkaloid, solasonin, m.p. 275-279°, and the alkaloid solasodin, m.p. 201-202° have also been isolated from the berries, and so also glucoside rutin, m.p. 260° which on hydrolysis gave quercetein, m.p. 314° and two sugars—glucose and rhamnose.

239. Studies on Halogenation of Benzalacetophenones-1—Bromination.

S. Y. AMBEDKAR, S. D. JOLAD and S. RAJAGOPAL, Dharwar.

A study of the bromination under controlled conditions of polyhdroxychalkones (partially alkylated) carrying reactive hydroxy groups in the ketonic half of the molecule has been made. The results are in agreement with the observations of Jadav and coworkers that nuclear bromination (at the 5′ position if this were free and at the 3′ position if the former be already substituted) precedes addition at the double bond when only one molecular proportion is employed. However with two or more molecular proportions of bromine or with liquid bromine addition as well as nuclear bromination take place. An electronic interpretation of the preferential nuclear bromination over addition at the double bond has now been offered.

240. Estimation of Nickel and Palladium by Semicarbazone of α-oximino Acetoacetanilide.

B. N. MANKAD and M. R. PATEL, Vallabh Vidyanagar.

αβ-dioximes are known for their wide application in the detection, separation and estimation of Palladium and Nickel. Dave and Talati (J. Ind. Chem. Soc. 1959, *36*, 179; ibid, 1959, *36*, 302) used αβ-dioximino acetoacetanilide for the estimation of Palladium and Nickel. It was therefore proposed to investigate the utility of semicarbazone of α-oximino acetoacetanilide as an analytical agent.

It was observed that Palladium forms a yellow complex and Nickel forms light yellow to red complex. The colour of Nickel complex varied with the

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change in pH. By analysis it is found that the complexes have the following compositions.

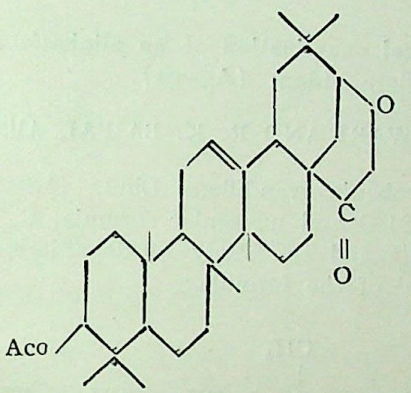
(i) $Pd(C_{11}H_{12}N_5O_3)_2$ Yellow.
(ii) $Ni(C_{11}H_{12}N_5O_3)_2$ Light Yellow.

Further work on other semicarbazones of α-oximino compounds of substituted amides of aceto-acetic acid is in progress. Thio-semicarbazones of the same compounds are under the process of investigation.

241. The study of Maharashtrian Albizzia Procera, Benth. Seeds.

I. P. VARSHNEY and Mohd. S.Y. KHAN, Aligarh.

The seeds of Albizzia procera Benth from Maharashtra yield a new saponin and sapogenin quite different from Proceranin and Machaerinic acid obtainable from Madhya Pradesh seeds (Arch. der Pharm. 1959, *292*, 57-62; Compt. rend., 1958, *246*, 3261-63; Current Sci., 1958, *27*, 489). The acetate of the genin, m.p. 288-90°, obtained by the hydrolysis of the saponin has been assigned the following tentative structure, and tentatively named Proceric acid.



242. High Resolution Nuclear Magnetic Resonance Spectra of Coumarins.

S. S. DHARMATTI, C. R. KANEKAR, C. L. KHETRAPAL and Y. P. VIRMANI, Bombay.

The high resolution proton magnetic resonance spectra of fourteen coumarin have been studied and compared with the theoretical spectra of the type AB, ABC and ABCD. Chemical shifts for protons in various positions in the Benzo-α-pyrone ring and spin coupling constants between these protons have been determined from such analysis. The spectrum of coumarin confirms the ethylenic nature of the double bond between carbon atoms in positions 3 and 4. The chemical shifts for the phenyl protons are in conformity with the reactivities of the coumarins at various positions in the ring. A linear relation has been observed between the chemical shift for proton in 8 position in various 6-substituted coumarins and the Hammett's δ Constants for substituents in the meta position. The NMR spectra offer a very convenient method for distinguishing between 3 and 4 substituted coumarins on account of the large chemical shift between the protons in 3 and 4 positions.

The results do not indicate resonance of the naphthalene type as suggested to explain the dipole moment of coumarin.

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243. Application of physical methods to the analysis of essential oils. Part IV: Ultra violet absorption spectroscopy.

S. S. NIGAM and (MISS) G. LAKSHMI KUMARI, Saugor, M.P.

Absorption maxima of anethole (λ_{max}=260 mμ, ε=18,600), methyl cinnamate (λ_{max}=272 mμ, ε=33, 930), citral (λ_{max}=244 mμ, ε=15, 880), β-ionone (λ_{max}=284 mμ, ε=27,800), pulegone (λ_{max}=224 mμ, ε=30,658), heliotropin (λ_{max}=244 mμ, ε=42,330), and methyl anthranilate (λ_{max}=230 mμ, ε=10,280) have been determined and the calibration curves of the first four prepared, to enable their estimation in essential oils. Spectroscopic method has been applied to estimate the percentage of anethole in fennel oils, methyl cinnamate in Ocimum basilicum oil and citral in lemon oil. Percentage composition of the mixtures of pulegone and methyl cinnamate, and heliotropin and methyl anthranilate has also been determined spectroscopically with the use of the simultaneous equations (given below) of Fearn.

$100 \times ABE^{1\%}_{1\ cm.}$ at λ_1 = % of $A \times AE^{1\%}_{1\ cm.}$ at λ_1 + % of $B \times BE^{1\%}_{1\ cm.}$ at λ_1 . . . . (i)

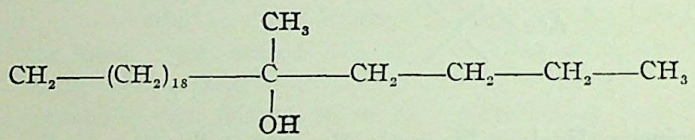
$100 \times ABE^{1\%}_{1\ cm.}$ at λ_2 = % of $A \times AE^{1\%}_{1\ cm.}$ at λ_1 + % of $B \times BE^{1\%}_{1\ cm.}$ at λ_2 . . . . (ii)

for a mixture of two compounds A and B having two maxima at λ_1 an λ_2.

244. Isolation and chemical examination of an aliphatic alcohol from the leaves of Sesbania Grandiflora, Linn. (Agasta).

R. D. TIWARI AND R. K. BAJPAI, Allahabad.

From the leaves of Sesbania grandiflora, Linn., (Agasta) a white, crystalline, aliphatic compound, m.p. 84°C and molecular formula, $C_{26}H_{54}O$ has been isolated. As a result of the analysis and the study of degradation products it has been found to be tertiary alcohol of the formula :



245. Diosgenin from *Dioscorea glauca*.

(MRS.) D. CHAKRAVARTI, R. N. CHAKRAVARTI, S. N. DASH and M. N. MITRA, Calcutta.

During 1951-54 a survey work was undertaken in this laboratory on the diosgenin content of the yams of a large number of *Dioscorea* plants growing in different parts of this country. Most of these yams were collected through the various forest offices. It was ultimately possible to find out two rich Indian sources for diosgenin—*Dioscorea deltoidea* (kins) of Kashmir and *Dioscorea prazeri* (kukur torul) of Darjeeling. In the present paper it is desired to deal with isolation of diosgenin from another plant of the *Dioscorea* family growing in Darjeeling, *Dioscorea glauca,* received from the Director, Medical Plants, Government of West Bengal. The yams of these plants are very similar to those of *Dioscorea prazeri* in appearance. The new yams were found to contain about 4·6 per cent of diosgenin.

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246. 2-Aminothiazole derivatives.

C. S. MAHAJANASHETTI and K. S. NARAGUND, Dharwar.

A series of 2-amino-4-benzoylthiazoles, having various substituents in the phenyl ring, and their respective 2-acetamido-5-chloromercuri and 2-acetamido-5-bromo derivatives have been prepared with a view to study their chemotherapeutic properties. 2-Amino-4-benzoylthiazoles were obtained by condensing 1-phenyl-3-bromo-1, 2-propanediones with thiourea. 2-Acetamido-4-benzoylthiazoles when treated with $HgCl_2$ solution gave corresponding 5-chloromercuri derivatives which were further converted to 5-bromo derivatives by the action of bromine. Some of the compounds were found active *in vitra tests* against *E. coli* and *S. aureus*.

247. Pyridine analogues of dads.

S. P. ACHARYA and K. S. NARGUND, Dharwar.

Phenyl 5-amino-2-pyridyl and phenyl 5-amino-3-chloro-2-pyridyl sulphides and sulphones having various substituents in the phenyl ring have been prepared with a view to study their pharmacological properties. 2-Chloro-5-nitropyridine and 2, 3-dichloro-5-nitropyridine have been condensed with 2, 4-, 3, 4- and 3, 5-dichlorothiophenols and chloro- and dichloro-p-hydroxythiophenols to obtain corresponding phenyl 5-nitro-2-pyridyl sulphides. These sulphides were oxidised to their respective sulphones employing hydrogen peroxide in glacial acetic acid. The various nitro-sulphides and nitro-sulphones were reduced to their corresponding amino-compounds by reduced iron and ammonium chloride. Most of the compounds are bacteriostatic against *E. coli* and *S. aureus in vitro* tests.

248. Ultraviolet absorption studies on Dixanthogens.

M. L. SHANKARANARAYANA and C. C. PATEL, Bangalore.

Absorption spectra of di-ethyl, di-isopropyl, di-n-butyl and di-isoamyl dixanthogens have been studied in the near ultraviolet region in polar and non-polar solvents. These compounds exhibit a low intensity band around 365 mμ and two high intensity bands around 286 and 242 mμ. Based on the solvent effect studies, the 365 mμ band assigned to $n \rightarrow \pi^*$ transition and the 285 mμ to $\pi \rightarrow \pi^*$ transition. The band around 242 mμ is due to the $n \rightarrow \sigma^*$ transition, since in polar solvent it shows mainly a blue shift.

249. A study of kinetics of bromination of cinnamic acid and its derivatives (Part I) in methyl alcohol as a solvent.

A. N. BOSE and V. K. SETH, Lucknow.

The bromination of cinnamic acid and its mono- and di-substituted derivatives was studied in methyl alcohol as a solvent. The rate of reactions was determined at different temperatures. By applying "least square method" for calculating the slope of a line, the energy of activation was calculated by using the values of specific rate constants at different temperatures. From these the values of logarithm of frequency factor, entropy of activation and free energy of activation were calculated. These values were found to be more or less constant throughout the series. The values of energy of activation of each compound were also calculated directly by using Arrhenius equation. Here the values of specific rate constants

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at a particular temperature, and frequency factor of cinnamic acid were used. These values were found to be in a good agreement with the experimental values of mono- and di-substituted cinnamic acids. The theoretical values of energy of activation of di-substituted derivatives were also calculated by adding the values of energy of activation of cinnamic acid and the substituent groups, and were in corroboration with the experimental value of energy of activation of those compounds. So it can be inferred that the resultant effect of two substituents is simply the sum of their individual effects and the reaction follows the rule of additive effect. By plotting the values of dissociation constants for the acids, for which the values of dissociation constants were available, a definite linear relationship was obtained. Thus the rate of reaction and the dissociation constants of acids were found to be closely related in a linear manner.

250. Application of physical methods to the analysis of essential oils. Part III. Polarography.

S. S. NIGAM and (Miss) G. LAKSHMI KUMARI, Saugor, M.P.

Examination of the polarograms of higher (hexanal to dodecanal) saturated aliphatic aldehydes has revealed that their reduction at the dropping mercury electrode takes place in a number of steps, probably involving the formation of alcohol, through an intermediate. The number of steps increases as the acidity of the buffer added increases. The half-wave potentials of the reduction steps of the 2, 4-dinitrophenylhydrazones of these aldehydes have been found to be almost similar, and thus are not suited for their estimation polarographically. The behaviour of the 3,5-dinitrobenzoates of a few alcohols and phenols have been studied in various buffer solutions. Mostly the reduction appears to occur in two stages, the first involving one electron, the second being irreversible. In addition to these, the polarograms of heliotropin, cyclamen aldehyde, hydroxy citronellal, cineol (1 : 8) and citral have been studied with a view to identify their presence in essential oils polarographically. Citral and cineol have also been quantitatively estimated in a few essential oils with the application of this method.

251. Organic fluorine compounds—Part IV. Electrophilic additions to fluoroallenes.

G. V. ASOLKAR, Nagpur.

The syntheses of stable fluoroallenes and related compounds have been recorded in the earlier communications (Proc. Ind. Sci Congr. 1958-60). This paper concerns the ionic additions and particularly the reactions of electrophilic reagents with these reactive systems.

The trifluoromethyl allene has been studied in some detail. The allene reacts with iodine monochloride and iodine monobromide smoothly to give $CF_3.CH:CI.CH_2X$ (X=Cl or Br) in almost quantitative yields establishing the

$$\delta- \quad \delta+$$

overall polarisation of the allene as $CF_3.CH:C:CH_2$. Reaction with chlorine at room temperature gives the dichloro compound $CF_3CH:CCl.CH_2Cl$. Trifluoromethyl allene failed to react with hydrogen chloride up to a temperature of 250-270°C even when anhydrous ferric chloride was used as a catalyst. On the other hand it reacts with hydrogen bromide to give $CF_3.CH:CH.CH_2Br$.

Investigations in the orientation arising when a mixed halogen like iodine monochloride and monobromide is added to an unsymmetrical allene have again yielded corresponding compounds as above establishing the overhaul polarisation

$$\delta- \quad \delta+$$

of the allene concerned as $CF_3.CH:C:CH.CH_3$ indicating the interesting reactions

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due to an electron attracting group at one end and electron releasing group at the other.

The identity of the new compounds presented is established by reference to these or related compounds obtained in the earlier free radical addition reactions studied (loc. cit.), and their infra red and ultra violet spectra.

The study of other allenes and addition of sulphur trioxide to these reactive systems is under progress.

252. High Resolution Nuclear Magnetic Resonance Spectra of some Trisubstituted Benzenes.

S. S. DHARMATTI, G. GOVIL, C. R. KANEKAR, C. L. KHETRAPAL and Y. P. VIRMANI, Bombay.

This paper presents the analysis of the proton magnetic resonance spectra of 2-chloro, 6-nitrotoluene; 2, 4-dinitrophenol; 1-chloro, 2, 4-dinitrobenzene and sodium hydrogen salt of 5-nitro, 3-sulphobenzoic acid. The phenyl protons in all these compounds form a system of 3 nuclei of the ABC type. The analysis has been made using the algebraic expressions given by Jha (Jha, S. S., Proc. Ind. Aca. Sci., 54A, 13, 1961) for the complete solution of the secular equation involved. The values of the chemical shifts and the spin coupling constants have been determined for each compounds by obtaining the best fit between the experimental and theoretical data for frequency separations and the intensities of the resonance lines.

253. Use of thiohydantoins and their mercurated derivatives, as fungicides and bactericides.

A. C. RATH and G. N. MOHAPATRA, Cuttack.

A number of aryl substituted thiohydantoins have been prepared by condensing symmetrical substituted di-aryl thioureas and N-substituted monoaryl thioureas with sodium ethoxide and benzil in presence of sodium acetate. (Angel Guillén, Chem. Abstr., 1951, 612 and Beritsch, 1911, Vol. I, page 411). These thiohydantoins have also been mercurated with mercuric acetate and glacial acetic acid. Since the thiohydantoin compounds contain the N-C-S group and exhibit medicinal, antiseptic and germicidal activities, both the parent thiohydantoin compounds and their mercurated derivatives prepared, have been assayed for antibacterial and antifungal activities.

254. Studies in 'The Cyclo-octane series' part I. The Synthesis of 1-Carboxy-Cyclostane-1-Acetic acid.

G. S. SAHARIA and M. P. TYAGI, Delhi.

In continuation of the earlier work on the study of the chemistry of cyclohexane and cycloheptane rings, we have extended this study to the cyclooctane ring system. The present investigations are devoted to the study of isomerism of the eight membered ring and in this work is described the synthesis of 1-carboxy-cyclo-octane-1-acetic acid.

Cyclooctanone was condensed with ethylcycloacetate to give ethyl cyclo-octylidene-cyano acetate, which was later condensed with potassium cyanide. This di-cyanoester on hydrolysis with hydrochloric acid gave only one 1-carboxy cyclo-

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octane-1-acetic acid m.p. 154°. The acid was characterised through its anilide, p-toluidide, anhydride, amide and S. benzyl-iso-thiouranium salt. Further work is in progress.

255. Synthetic studies in the indole field. Part II—Some 7-Nitroindole derivatives of biological interest.

S. P. HIREMATH and S. SIDDAPPA, Dharwar.

The synthesis of 7-nitro-3-indoleacetic acid, 7-nitro-β-(3-indolyl)-lactic acid, and aldehydes derived from 7-nitroindole, which are all of biological interest are described in the paper. 3-Diethylaminomethyl-7-nitroindole (I) was converted into its methiodide, m.p. 173-4°, and reacted with sodium cyanide to obtain 7-nitro-3-indoleacetonitrile, m.p. 207-8°, which on hydrolysis gave 7-nitro-3-indoleacetic acid, m.p. 200°, which is of interest as a plant hormone. 7-Nitro-3-indolealdehyde, m.p. 210°, and 7-nitro-2-carbethoxy-3-indolealdehyde, m.p. 180°, have been synthesised and their corresponding thiosemicarbazones prepared with a view to test them for antitubercular properties. The compound (I) on reaction with diethyl acetoxymalonate and hydrolysis of the resulting product gave 7-nitro-β-(3-indolyl)-α-hydroxy-α-carboxypropionic acid, m.p. 170°, which on decarboxylation gave the required 7-nitro-β-(3-indolyl)-lactic acid.

256. Mercurated Dyes, Part V : Preparation of some Azo Dyes.

J. K. SAXSENA, H. L. ROHATGI and A. N. DEY, Kanpur.

In a previous paper of this series (Proc. Ind. Sci. Congr., 1960) we have described the preparation of antifungal properties of some mercurated dyes obtained by coupling diazotised mercurated bases with phenols. In continuation of the same work we have described in this paper the preparation and properties of further samples of the type as were obtained from Scarlet G base (2-methoxy-5-nitroaniline). For the purpose the base was mercurated to furnish a monomercurated base which after diazotisation was coupled with phenol, o, m and p-cresole, resorcinol, α- and β-naphthols, Scaffers salt and N W acid. The mercurated dyes were also tested for their fungicidal properties.

257. Mercurated Dyes, Part VI: Preparation of some mercurated Phthaleins.

J. K. SAXSENA, H. L. ROHATGI and A. N. DEY, Kanpur.

In contradiction to what has been noted by earlier workers it was observed that 3-nitro phthalic anhydride on condensation with phenol gives two isomeric phthaleins. They have been separated from each other with the help of different solubilities of their acetyl derivatives in water. Their probable constitution has been indicated. Similarly the same anhydride on condensation with resorcinol also gives two isomeric fluoresceins which were separated through their acetyl derivatives. The dyes obtained from these acetyl products have been brominated and mercurated to give the mercurochrome type of compounds.

4-nitrophthalic anhydride also gives two sets of isomeric compounds with phenol and resorcinol.

The mercurated compounds have been examined for their antifungal properties.

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258. Experiments on the Synthesis of cadinene. Part I. Synthesis of 5-methoxy-8-isopropyl tetralone.

JADUGOPAL DUTTA and SIPRA MUKHERJEA, Calcutta.

A synthesis of 5-methoxy-8-isopropyl-tetralone (1) has been described. p-Isopropylanisole was condensed with succinic anhydride. The resulting keto acid was reduced by Clemmensen method to yield γ-(2-methoxy-5-isopropyl-phenyl)-butyric acid which on cyclisation gave 5-methoxy-8-isopropyltetralone.

259. On the saponin and sapogenin of Albizzia odoratissima Benth seeds collected from Uttar Pradesh.

I. P. VARSHNEY and MOHD. S. Y. KHAN, Aligarh.

The seeds of Albizzia odoratissima Benth collected from the state of Uttar Pradesh yield a colourless product m.p. 227-228° which gives all the tests for saponin. On hydrolysis it yields an acid sapogenin m.p. 296-299°, acetate m.p. 265-276°, methyl ester m.p. 213-215°, acetyl methyl ester m.p. 201-202° and diacetyl bromo-lactone m.p. 180-182°. It has been identified as echinocystic acid (3β, 16α-dihydroxy-Δ ^{12}-oleanene-28-oic acid or 16α-hydroxy oleanolic acid) by mixed melting point and Infra-red spectra with authentic samples of echinocystic acid and derivatives (cf. Ch. Sannié H. Lapin and I. P. Varshney, Bull. Soc. Chim. France, 1957, 1440-44). This carries glucose, xylose, arabinose and rhamnose as sugars. In contrast to this the seeds from the state of Maharashtra contain machaerinic acid (3β, 21β-dihydroxy Δ ^{12}-oleanene-28-oic acid) (c.p. I. P. Varshney and Mohd. S. Y. Khan, J. Pharm, Sci., in the press).

260. On the isolation and constitution of saponin from the seed kernels of Balanites roxburghii. Planch.

I. P. VARSHNEY and K. M. SHAMSUDDIN, Aligarh.

The fruits of Balanites roxburghii, Planch obtained from U.P. gave 7·8% pericarp, 10% brown pulp, 72% seed coat and 9·6% seed kernels. The seed kernels yield 40% golden yellow oil and a colourless chromatographically and electrophoratically pure saponin m.p. 182-186°. On hydrolysis it gave a steroidal sapogenin m.p. 194-198°, acetate m.p. 201-203°. The genin has been identified as diosgenin by mixed melting point and infra-red spectra with authentic samples of diosgenin and its acetate. The earlier reported kryptogenin could not be obtained. The sugars present are glucose, xylose and rhamnose.

261. Fractionation of Beeswax and its Alcohols with urea.

T. N. MEHTA and B. N. MURTHY, Nagpur.

Bees-wax obtained locally was analysed for its constants which are as follows : Iodine value 7·60, Saponification value 97·8, Acid value 6·13 and Hydroxyl value 16·51. The wax was saponified, and the alcohols and hydrocarbons were separated from the unsaponifiable portion. The alcohols were acetylated and the acetates were fractionated with urea for finding the fatty alcohol composition which is as follows : C_{24}—0·87%, C_{26}—26·28%, C_{28}—44·04%, C_{30}—26·79%, and cyclic and branched alcohols 2·01%.

Fractionation of beeswax with urea suggests its use for deriving hard and soft varieties of the wax which are useful in the manufacture of cosmetics, candles and other products.

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262. Fractionation of Fatty Acids.

T. N. MEHTA and B. N. MURTHY, Nagpur.

The fatty acids of beeswax were resolved into three groups by extraction with aqueous alcohol. The ethyl esters of these were fractionated with urea to arrive at the fatty acid composition which is as follows : Hydroxy acids 20·28% unsaturated acids 9·80% and saturated acids 69·94%. C_{16} and C_{18} acids were found to be the most predominant among the saturated acids. Fractionation of ethyl esters of the mixed acids of beeswax with aqueous 55% ethanol indicated the proportion of hydroxy and unsaturated acids to be 22·15% and 9·11% respectively.

263. The Isolation of acacic acid from the bark of Albizzia Lebbeck Benth.

H. HASAN, I. P. VARSHNEY and S. ANSAR AHMED, Aligarh.

The bark of Albizzia lebbek Benth 'Siris' yields a saponin which on hydrolysis gives a triterpenic acid sapogenin with a formula $C_{30}H_{48}O_5$ m.p. 273-74°, acetate m.p. 235-236°. It has been shown to be identical with Acacic acid, a new triterpenic acid earlier isolated from Acacia intsia Willd bark (Cf. M. O. Farooq, I. P. Varshney and Z. Naim, Arch. der Pharm., 1961, *294*, 133-137) by mixed melting point and infra-red spectra.

264. Physical and chemical properties of Shaal-seed oil.

D. MISHRA, Phulbani.

The physical and chemical properties of shaal-seed oil have been studied in details. Under physical (1) melting points, (2) specific gravity, (3) refractive index both (a) Abbe and (b) Butyro, (4) smoke point and (5) moisture and volatile matter were studied and under the chemical properties (1) acid value, (2) saponification value, (3) iodine value, (4) unsaponifiable matter, (5) Reichert Meissel value, (6) Reichert Polenske value, (7) peroxide value, (8) acetyl value, (9) Diene value, (10) Hehner value and (11) Baudouintest were carried out with a view to use this oil in animal experiment along with butter and groundnut oil.

265. Action of some oxidising agents on 2-mercapto-3-aryl quinazol-4-ones.

G. C. AMIN, (Shahad) Kalyan.

Twelve 2-mercapto-3-aryl quinazol-4-one substituted in the aryl side chain were oxidised by (i) potassium permanganate, (ii) hydrogen peroxide and (iii) chlorine gas in alkaline medium. All the three oxidising agents gave the same 3-aryl-2 :4-diketo-tetrahydro quinazoline derivative in each case.

266. Examination of fatty lipids of sugarcane wax for sterols.

S. BOSE and K. C. GUPTA, Kanpur.

Fatty matter obtained from crude sugarcane wax was dewaxed with acetone and examined for the presence of different sterols. On hydrolysis with ethanolic caustic potash it produced unsaponifiable matter (yield 45%) which on fractional crystallisation from 95% alcohol afforded crude sterols (yield 24·7%). They were found to be a tenacious mixture of sito and stigmasterols and could not be resolved into its components either by repeated fractional crystallisation or by chromatography. By applying Windaus and Hauth's procedure the crude sterol mixture

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was, however, separated into crystalline tetrabromostigmasterol acetate and soluble dibromositosterol acetate fractions. By debromination and deacetylation tetrabromostigma sterol acetate, m.p. 209-10° was converted into stigmasterol, m.p. 169-70° $[\alpha]_D^{28} = -46°$ (chloroform). Dibromositosterol acetate, upon debromination and subsequent chromatography over activated alumina, furnished pure acetyl compound, m.p. 127-28° $[\alpha]_D^{28} = -40°$ (chloroform). It was deacetylated to yield a crystalline substance which after several times crystallisation from methanol showed m.p. 139-140°, $[\alpha]_D^{28} = -37°$ (chloroform) characteristic of β-sitosterol. The yield of β-sitosterol and stigmasterol from unsaponifiable fraction was found to be 5·6% and 13·37% respectively.

Fatty matter, when subjected to alcohol fractionation procedure directly, produced crude sterol in a yield of 8·01%. By adopting the above procedure it was separated into stigmasterol and β-sitosterol, their yields being 0·69 and 2·66% respectively. During alcohol fractionation of fatty matter, a low melting solid (m.p. 70-80°) was obtained in a very small amount. Purification of the compound by column chromatography raised its m.p. to 80-83°. Upon acetylation it produced a monoacetyl derivative, m.p. 64-65°. A comparison of the m.p. of the original compound and its acetyl derivative with those of the existing higher alcohols establishes its identity with n-octacosanol.

267. The structure of Salmalia malabaricum (Syn. Bombax malabaricum) gum part I. Nature of sugars present.

S. BOSE and A. S. DUTTA, Kanpur.

Crude *Salmalia malabaricum* gum, commonly known as "Semul" gum has been purified by precipitation from an acidified aqueous solution by addition of absolute alcohol. Pure gum is insoluble in water and has an ash content, 0·426; pentosan, 13·9 and pentoses, 15·89 per cent. Complete acid hydrolysis of the gum furnished neutral sugar fraction (A) and barium salt of uronic acid (B). Paper chrmotographic examination of (A), using n-butanol-ethanol-water (5 : 1 : 4) as irrigating solvent and silver nitrate spray reagent, indicated the presence of arabinose, galactose and probably rhamnose. By cellulose column chromatography, (A) was resolved into two homogenous crystalline components which were identified as L-arabinose and D-galactose from a measurement of specific rotation and preparation of their characteristic crystalline derivatives. Quantitative hydrolysis showed that D-galactose and L-arabinose were present in the gum in 2 : 1 proportion. Uronic acid liberated from fraction (B) was identified as gelactouronic acid from (a) paper chromatographic examination [Irrigating solvent : n-Butanol-acetic acid-water (4 : 1 : 5); sprayreagent, p-anisidine phosphate], (b) positive basic lead acetate test and (v) oxidation to mucic acid, m.p. 212°. For further confirmation about its nature, methylester methyl glycoside of the uronic acid (B) was subjected to sodium borohydride reduction and acid hydrolysis when D-galactose was obtained as the neutral sugar. During acid hydrolysis or when the suspension of gum in water is heated, arabinose is released first. The easy elimination of the pentose indicates its presence in the furanose from within the gum structure.

268. The hemicellulose from bagassee. Part II. Isolation of a xylan and dl-xyloketose.

B. C. BANERJEE, S. BOSE and S. MUKHERJEE, Kanpur.

An alkaline solution of bagassee hemicellulose, upon treatment with Fehling's solution, gave a dark blue precipitate of copper complex which after decomposi-

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tion with cold hydrochloric acid was diluted with a large excess of acetone. The precipitated polysaccharide was washed with water and resubjected to the above procedure when a pure xylan fraction (sulphated ash 0·33%, Pentosans 98·6%) was obtained. On complete hydrolysis it gave rise to a single sugar, namely, Xylose. By hypoiodite oxidation method the degree of polymerisation and the molecular weight of the Xylan has been estimated to be 65-70 and 9000 respectively.

Bagasse hemicellulose, upon acid hydrolysis, furnishes an unknown sugar in a very small amount along with D-glucose, L-arabinose and D-xylose. The Rf value of the sugar indicates that it might be either 3-O-methyl glucose or a keto-pentose. The former possibility is ruled out from the behaviour of the sugar when its paper chromatogram is sprayed with specific ketonic reagents like p-anisidine phosphate, Sodium metaperiodate, Benzidine B-Benzidine-A and Resorcinol-ethanolic hydrogen chloride. In every case, characteristic colour corresponding to keto-pentose is developed. By cellulose column chromatography the unknown sugar has been obtained in a homogenous state in the form of a syrup. It produces a crystalline osazone, m.p. 202-204°. The high m.p. indicated that it might be DL-Xylosazone (Reported m.p. in the literature is 207°). Further identity of the sugar osazone was established by conducting its paper chromatography on a borax buffered filter paper, using 75% dioxane-hexane-water-benzene (55 :50 :25 :20; upper layer) as the irrigating solvent, along with authentic samples of L-arabino-sazone and D-xylosazone. The unknown osazone moved at the same rate as xylo-sazone, thereby establishing that the corresponding sugar must be DL-xyloketose. That this sugar is not an artifact is proved from the fact that neither pure xylose nor xylan, isolated from the hemicellulose, gives rise to it when warmed with dilute acid. Therefore it is concluded that Dl-xyloketose is present as a part of the hemicellulose structure.

269. The structure of Chloroxylon swietenia gum. Part I. Nature of sugars released on graded hydrolysis.

S. BOSE, N. N. MODY and S. MUKHERJEE, Kanpur.

Chloroxylon swietenia gum, commonly known as "Satinwood gum", is almost insoluble in water in the crude state. Once purified by precipitation process, the gum becomes water soluble. Ion-exchange resin treatment of the aqueous solution of the gum and subsequent precipitation with acetone resulted in the production of the pure gum acid in the form of a white powder $[\alpha]_D^{29} = -20{\cdot}96°$. It has an equivalent weight 1200, ash, 0·43, methoxyl, 4·43; pentosan 30·38 and pentoses (calculated from pentosans), 34·53 per cent. Autohydrolysis of the gum produces a degraded gum and sugar mixture. Chromatography of the sugar mixture on filter papers and also on cellulose column definitely settled the presence of L-arabinose and D-galactose which were identified from their m.ps., specific rotation and the m.ps. of their characteristic crystalline derivatives. Besides them, the presence of two other sugars (Rg. 0·30 and 0·26 respectively) in very small amount have been noted. They have been provisionally identified as rhamnose and fucose. In this experiment, the amount of arabinose was found to be higher than that of galactose. Mild hydrolysis of the degraded gum resulted in the production of aldo-bionic acids and a sugar mixture consisting of more of galactose and less of arabinose. Paper chromatography and subsequent acid hydrolysis with normal sulphuric acid revealed the mixed character of aldobiuronic acids which gave rise to uronic acid mixture and galactose. In the hydrolysate, traces of arabinose were also noticed. Using different irrigating solvents in the process of paper chromato-graphy, one of constituents of the uronic acid mixture has been identified as D-galactouronic acid. Conversion of the Uronic acids into neutral sugars yielded a mixture, in which the presence of D-galactose has been established.

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270. Reactivity of Pyridine: Part IV.

B. J. GHIYA and M. G. MARATHEY, Amravati.

In connection of our study of the reactivity of pyridine, a newly discovered property of pyridine in this laboratory, it has been reported in our earlier communications (J. Sci. industr. Res., *20B*, (1961),—Part I and II) that pyridine reacts with chalkone dibromides and the mechanism of the reaction involves three major steps; (i) debromination, (ii) unclear substitution and (iii) oxidative cyclization. The reaction depends upon the structure of the chalkone as a whole. 2′-Hydroxy-5′-methyl-4-methoxy chalkone dibromide with pyridine in presence of sodium thiosulphate was refluxed for 15 min. 2′-Hydroxy-5′-methyl-4-methoxy chalkone was obtained. 2′-Acetoxy-5′-methyl-4-methoxy chalkone dibromide on treatment with pyridine gave 2-acetoxy-5′-methyl-4-methoxy chalkone. This mechanism suggested agrees well as the predicated intermediates have been isolated. The reactivity of pyridine was also studied on the substances other than chalkone dibromides on similar ground.

271. Bromination of Benzo-pyrones.

K. B. DOIFODE and M. G. MARATHEY, Amaravati.

Bromination of 4-methyl-5-hydroxy-6-acetyl coumarin, I, m.p. 164°, with one mole of bromine in AcOH was reported to give two isomeric monobromo compounds. In the present work it was found that only one monobromo compound, II, m.p. 226°, was obtained and the reported second compound was a mixture of II and I.

Action of 10% Na_2CO_3 on II gave a compound, III, m.p. 81°, as reported earlier. 3-Methyl-4-hydroxy-5-acetyl coumarone, m.p. 71°, IV, has been synthesised earlier by Limaye and others. The compound, III, which should in ordinary course be IV is found to be different and the structure is being investigated.

272. Reactivity of Pyridine: Part V.

(Miss) KUNDA R. KUTUMBE and M. G. MARATHEY, Amravati.

Pyridine reacts with chalkone dibromides giving bromo flavones by abstracting bromine, forming Py. Br. Br. complex and nuclear bromination and oxidative cyclisation, the final product obtained being dependent on the structure of the molecule. The B-ethoxy derivative when treated similarly is found to remain unchanged. Even the B-hydroxy derivative, which is so reactive as to give a flavonol on treatment with alkali, remains unchanged when treated with pyridine. These reactions indicate that pyridine does not always behave as a normal base.

4′-Methoxy-6-methyl benzylidenecoumaranone dibromide when treated with pyridine has been found to undergo debromination giving back the corresponding benzylidene coumaranone.

273. Changes in the Component Fatty Acids of Mango-seed Oil During Development.

S. P. PATHAK and A. K. VASISHTHA, Varanasi.

General characteristics and fatty acid composition of mango-seed oil was studied at different stages of development. It was found that as the age of

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development is advanced the fat content shows a gradual rise and the free fatty acid goes on decreasing. The increase in unsaturation after the commencement of rainy season shows a marked effect of environmental conditions in which the development is taking place.

The study is unique of its kind on a non-drying type of oil and confirms that in seeds of same species, the relative proportions of oleic and linoleic acids may vary considerably and such variation may be conditioned by the temperature of the locality where the seed ripens, and strongly supports the view that the typical unsaturated acids are built up by different mechanism to that which operates in the biosynthesis of the saturated acids. A more detailed work of this type on a non-drying oil is also suggested.

274. Component Fatty Acids of an Indian Fresh-water Fish Labeo calbasu Oil.

S. P. PATHAK and B. C. L. AGRAWAL, Varanasi.

In the present work the fatty acid compositions of body and visceral oils from fresh water fish *Labeo calbasu* have been studied. The body and the visceral oils were hydrolysed and the recovered mixed fatty acids were resolved into groups of simpler mixture of acids differing in unsaturation by the Lithium salt-acetone method followed by the Lead salt-ethanol method. Each group was methylated and the esters were fractionated separately under high vacuum using electrically heated and packed column. The fatty acid compositions were calculated from the saponification equivalents and iodine values of each of the sub-fractions. The body fat contains 35·74% saturated acids (myristic 1·00%, palmitic 22·11%, stearic 11·32% and arachidic 1·31%) and 64·26% unsaturated acids (C_{14} 0·95%, C_{16} 12·58%, C_{18} 39·92%; C_{20} 8·19% and C_{22} 2·62%). The visceral fat contains 38·82% saturated acids (myristic 2·07%, palmitic 24·95%, stearic 10·79% and arachidic 1·01%) and 61·18% unsaturated acids (C_{14} 0·65%, C_{16} 13·00%, C_{18} 36·38%, C_{20} 9·16% and C_{22} 1·99%).

The mean unsaturation of acids are −2·0, −3·1, −4·2, −5·7 and −7·0 of C_{14}, C_{16}, C_{18}, C_{20} and C_{22} acids respectively in the body fat and −2·0, −2·2, −2·6, −5·3 and −8·0 of C_{14}, C_{16}, C_{18}, C_{20} and C_{22} acids respectively in the visceral fat.

275. Studies on sardine oil—extraction from press liquor and its stabilization.

N. L. LAHIRY, Mysore.

Sardine oil, as extracted by indigenous method, is of poor quality. According to Vasavan and co-workers, at least about 560,000 lbs. of sardine oil was extracted in Malabar coast alone during 1957-58.

A method for extraction of good quality sardine oil from the press-liquor from body and from head and entrails have been described. The oils thus extracted were found to give no foul smell on storage. The oil samples were studied with respect to refractive index, optical densities, colour, iodine value, saponification value, non-saponifiable matter, free fatty acids, peroxide value. Stability study by weighing method for a period of 815 hours (34 days) with different antioxidants, namely, prophyl gallate, BHA, BHT (with and without citric acid) and hydroquinone, indicating hydroquinone at 0·50% level, was the most effective antioxidant for sardine oil, next in order BHA, BHT and PG. Final free fatty acid content, peroxide value and aldehyde value, also corroborated this.

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276. Studies on the chemical qualities and storage behaviour of sun-dried salted fish as available in market.

N. L. LAHIRY, Mysore.

Dry-curing of fish is an established trade practice in India. Yet, the products obtained are without any standard. Also, these products cannot be stored for long, and thus, the very purpose of curing is often lost.

The present investigation was undertaken to determine the chemical and the organoleptic qualities of fifteen different samples of dry-cured fish as available in the market in order to assess the variations in the chemical parameters and also to determine their culinary quality.

Simultaneously, storage behaviour of six market samples of dry-cured fish under control humidity conditions and also under sealed conditions, were studied, with a view to determine their storage life and associated problems.

Results indicated that the products varied widely in their chemical and organoleptic properties. Storage behaviour under control humidity conditions at room temperature, indicated that product became inedible by 32-33 days at 75-100% R.H., and by 85-90 days at 63% R.H. In sealed containers at room temperature, products studied became inedible in 45-65 days period.

277 Studies in the cycloheptane series Part VII. The syntheses of benzcycloheptane-3-spiro-2′-methyl-cyclopentane and 8-methylbenzcycloheptane-3-spiro-2′-methylcyclopentane.

K. C. MATHUR and G. S. SAHARIA, Delhi.

The present work describes the syntheses of benzcycloheptane-3-*spiro*-2′methylcyclopentane and 8-methylbenzcycloheptane-3-*spiro*-2′-methylcyclopentane. 3-Methylcyclopentanone was condensed with ethyl cyanoacetate in presence of alcoholic ammonia to give the corresponding dicyanoimide, which on hydrolysis furnished 3-methylcyclopentane-1 :1-diacetic acid. Its anhydride on Friedel and Crafts reaction with benzene and toluene gave the corresponding keto-acids. It may be mentioned here that of the expected two isomeric keto acids only one was isolated inspite of repeated trials. These keto acids on reduction by Wolff-Kishner's method and cyclisation by internal Friedel and Crafts reaction yielded the cyclic ketones. Final reduction of these ketones to benzcycloheptane-3-*spiro*-2′-methylcyclopentane and 8-methylbenzcycloheptane-3-*spiro*-2′-methylcyclopentane was carried out by Wolff-Kishner's method.

278. Studies in the cycloheptane series part VI. The syntheses of benz-3-methyl-3-ethylcycloheptane and 8-methylbenz-3-methyl-3-ethylcycloheptane.

K. C. MATHUR and G. S. SAHARIA, Delhi.

In continuation of our earlier work, the syntheses of benz-3-methyl-3-ethylcycloheptane and 8-methylbenz-3-methyl-3-ethylcycloheptane have now been carried out. The starting material β-methyl-β-ethylglutaric acid was prepared from methyl ethyl ketone through Guareschi condensation. The anhydride of this acid was then condensed with benzene and toluene under the conditions of Friedel and Crafts reaction, when the corresponding γ-aroyl butyric acids were obtained. These acids when reduced by Clemmensen's method gave δ-arylvaleric acids which were cyclised through their acid chlorides and the cyclic ketones thus obtained on Clemmensen's reduction yielded the hydrocarbons, benz-3-methyl-3-ethylcycloheptane and 8-methylbenz-3-methyl-3-ethylcycloheptane.

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279. Studies on C-Methyl-γ-Benzopyrone system-orientation in isoflavone series.

W. RAHMAN and KH. TAKRIMULLAH NASIM, Aligarh.

The ethoxalylation of 4′-and 2′-methyl ethers of 2,4,6-trihydroxy-3-methyl deoxybenzoin has resulted in the formation of an isomeric mixture of isoflavones of 5,6,7-and 5,7,8-orientations. The orientation of each isomer has been authenticated by comparison with synthetic standards. The investigation of the condensation of 2,4,6-trihydroxy-3-methyl deoxybenzoin with acetyl chloride and pyridine at 0° (followed by refluxing with aqueous sodium carbonate) and acetic anhydride and sodium acetate at high temperature has also given rise to isomeric mixtures of 2-methyl isoflavones of the same orientations. The dual course of very facile Baker-Venkataraman transformation followed by isoflavone ring closure has been suggested for the formation of isomeric mixture in each case.

280. Addition of Dienophil to Undecylenic acid.

M. MUKHERJEE and A. N. SAHA, Calcutta.

Reaction between Undecylenic acid and $CH_2=CH\text{-}CHO$ was effected at different temperatures namely 160, 180, 200°C with yields of products 53·8, 60·0, 65·0, respectively. The reaction time in each case is four hours. The product is a dark brown coloured viscous liquid. No stereomeric forms could be isolated.

281. Naturally occuring Antidiabetic Principles.

H. D. BRAHMACHARI and K. T. AUGUSTI, Pilani.

A large number of indigenous plants of India have been claimed to contain antidiabetic principles by various workers. Some of these plants have even been reported to contain orally effective substances. An orally effective hypoglycemic principle was extracted by the authors from the common onion bulbs and reported last year (Proc. Ind. Sci. Cong. III, 1961). A systematic examination of all the plants claimed to have antidiabetic properties have been undertaken in this laboratory and a preliminary report on the results obtained so far is presented here.

The roots, leaves, barks or fruits of the plants concerned were crushed in a ball mill after thorough drying and extracted with the different solvents. These extracts were carefully dried under vacuum and the solid residues fed to groups of normal fasting (18 hrs.) rabbits in fixed doses and the hypoglycemic activity, if any, studied for a period of 3-4 hrs., and compared to that produced in a set of control animals fed with a standard dose of tolbutamide.

Alcoholic extracts of the barks of Ficus bengalensis and Ficus religiosa and that of the seeds of Eugenia jambolana were found to be orally effective; while watery, alcoholic and ether extracts of Vinca rosea (leaves), Tinospora Cordifolia (stem), Cassia auriculata (flowers and seeds), Melia azadirachta (leaves), Cocus nucifera (flowers), Cassia glauca (leaves), and Premna integrifolia (roots) were found to be completely ineffective orally.

282. Large scale Extraction of Psoralen-Isopsoralen from Psoralea Corylifolia (Babchi).

S. J. DAS GUPTA, Calcutta.

Psoralea Corylifolia (Babchi) is a very ancient remedy for leucoderma. It has been tried extremely not only by the practitioners of Hindu medicine but also by

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followers of Western system. Recent investigations have shown that seeds of Psoralea Corylifolia contain two furano coumarin compounds—Psoralen (m.p. 169°) and Iso-psoralen (m.p. 142°) in small quantities, which are useful in the treatment of certain types of leucoderma. Generally the two compounds are isolated in the form of a mixture. A method for large-scale extraction of Psoralen-Isopsoralen from seeds of Psoralea Corylifolia for commercial purposes has been described in the present paper.

500 lbs. of fresh and dried seeds were powdered to 30 mesh in a pulveriser and soaked in water. The powder after being dried was introduced into a soxhlet type extractor made of copper and steam jacketted. 160 gallons of solvent oil was used for extraction. About 90% of the solvent was recovered. The crude psoralen-Isopsoralen which was obtained from the residue was purified by treatment with alcohol and activated charcoal. Yield—2·7 to 0·8%.

283. Coal gas as a substitute for synthetic gas in the Fischer-Tropsch reactions, Part IV. "Variation of reaction characteristics with time".

G. C. BASAK and N. C. NIYOGI, Howrah.

The work embodied in the paper is a continuation of the investigation undertaken for the past few years to study the reaction characteristics of the Fischer-Tropsch type synthesis with coal gas on a Cobalt-base catalyst. The present investigation sought to test the activity of the catalyst and study the nature of reaction products by using the catalyst over extended periods lasting 100 hours at a time at a constant temperature of 180°C and continuing the same study by reactivating the catalyst every 100 hours. The results indicate that the activity of catalyst and conversion into hydrocarbon products reach maximum values within 12 hours of the start of the reaction after which these decline at more or less steady rates. The activity is restored by reactivating the catalyst by hydrogenation for one hour at 400°C. The significant observation was made that the catalyst showed increased activity and better capacity for producing larger amounts of hydrocarbons other than CH_4, when the same catalyst was used over and over again after reactivation each time, than a freshly once-reduced catalyst.

284. Possible Antiamoebic Agents. Part XVI.

A. B. SEN and S. K. GUPTA, Lucknow.

Twenty five new N-substituted-2-amino-pyridines and pyrimidines have been prepared with a view to test their antiamoebic activity (cf. Neal & Vincent, Brit. J. Pharm., 1955, *10*, 434; Brown et. al., J. Chem. Soc., 1950, 1945; Waletzky et. al., Science, 1950, *111*, 720).

The N-substituted-2-amino-pyridines were obtained by condensing 2-chloro-5-nitro-pyridine with appropriate amines; while N-substituted-2-amino-pyrimidines were obtained by refluxing 2-methylthio-pyrimidines with appropriate amines at 170°C.

285. Coumarino-α-pyrones and Furocoumarins.

K. N. TRIVEDI and SURESH SETHNA, Baroda.

7-Hydroxy-3 : 4-dimethylcoumarin when condensed with malic acid gave 3 : 4-dimethylcoumarino-7 : 8-α-pyrone. The structure was proved by direct comparison with the product obtained on Perkin acetylation of 7-hydroxy-8-formyl-3 : 4-dimethylcoumarin. The structure of 7-hydroxy-8-formyl-3 : 4-dimethylcoumarin was proved

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by converting it to the known 7 : 8-dihydroxy-3 : 4-dimethylcoumarin by Dakin Oxidation. 7, 8-Dihydroxy-3 : 4-dimethylcoumarin and 5-hydroxy-3 : 4 : 7-trimethylcoumarin on similar condensation with malic acid gave 8-hydroxy-3 : 4-dimethylcoumarino-7 : 6-α-pyrone and 3 : 4 : 7-trimethylcoumarino-5 : 6-α-pyrone respectively. 7-Hydroxy-4 : 8-dimethylcoumarin and 7-hydroxy-4 : 6-dimethylcoumarin did not condense with malic acid.

7-Hydroxy-3-bromo-4-methylcoumarin when condensed with malic acid gave 3-bromo-4-methylcoumarino-7 : 8-α-pyrone. It was also obtained by the bromination of 4-methylcoumarino-7, 8-α-pyrone. This compound, on hydrolysis with alcoholic potassium hydroxide solution, gave furo-3′-methyl-4′, 5′, 5, 6-coumarin-2′-carboxylic acid which afforded furo-3′-methyl-4′,-5′,-5, 6-coumarin on decarboxylation with copper and quinoline. 7 : 8-Dihydroxy-3-bromo-4-methylcoumarin on similar condensation with malic acid gave 8-hydroxy-3-bromo-4-methylcoumarino 7, 6-α-pyrone. Attempts to synthesize 3-methylxanthotoxol and 3-methylxanthotoxin by hydrolysizing the bromo compound by alcoholic potassium hydroxide solution, or sodium carbonate solution met with failure. 7-Hydroxy-3, 8-dibromo-4-methylcoumarin and 7-hydroxy-3, 61dibromo-4-methylcoumarin did not condense with madic acid.

286. Chloromethylation of some chromones and flavones.

M. V. SHAH and SURESH SETHNA, Baroda.

2-Methylchromone and flavone on chloromethylation even with excess of paraformaldehyde gave only the 3-chloromethyl derivatives. These were reduced to the corresponding 3-methyl derivatives and compared with the authentic specimens. 7-Methoxy-2-methylchromone and 7-methoflavone on chloromethylation gave the 8-chloromethyl derivatives. On reduction they gave the corresponding methyl derivatives which were found to be identical with the methyl ethers of the products obtained on condensation of 2-methyresorcinol with ethyl acetoacetate and ethyl benzoylacetate respectively in boiling diphenyl ether. On further chloromethylation the 3, 8-dichloromethyl derivatives were obtained which on reduction gave 7-methoxy-2, 3, 8-trimethylchromone and 7-methoxy-3, 8-dimethylflavone as seen by direct comparison with authentic specimens.

287. Synthesis of some bichromonyls, biflavonyls and 7-methoxy-8-phenyl-2-methyl-chromone and -flavone.

M. V. SHAH, Baroda.

7-Methoxy-6-iodo- and 7-methoxy-8-iodo-2-methylchromone and 7-methoxy-8-iodoflavone have been converted into the corresponding bichromonyl and biflavonyl derivatives by the Ullmann reaction. 7-Methoxy-6-iodo-3-benzoylflavone on a similar Ullmann reaction give the 6, 6′-biflavonyl derivative.

7-Methoxy-8-iodo-2-methylchromone and 7-methoxy-8-iodoflavone on crossed Ullmann reaction with iodobenzene gave the corresponding 8-phenyl derivatives.

The above bichromonyls, biflavonyl and 8-phenyl derivatives except 7, 7′-dimethoxy-3, 3′-dibenzoyl-6, 6′-biflavonyl were demethylated to the corresponding hydroxy compounds.

288. Mannich reaction on some coumarin derivatives.

M. G. PATEL and SURESH SETHNA, Baroda.

7-Hydroxycoumarin (I) on reaction with one mole of paraformaldehyde and dimethylamine (A) gave the 8-dimethyl aminomethyl derivative. Its structure was

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proved by converting it into the known 8-formyl derivative by heating with hexamine. (I) with benzylamine (B) gave mainly 2′ H-3′-benzyl-3′, 4′-dihydro-1′, 3′-oxazino-5′, 6′, 8, 7-coumarin with a small quantity of 7-hydroxy-8-benzylaminomethyl derivative and with aniline (C) it gave mainly 2′ H-3′-phenyl-3′, 4′-dihydro-1′, 3′-oxazino, 5′, 6′, 8, 7-coumarin with a small amount of 7-hydroxy-8-anilinomethyl-coumarin. The oxazino derivatives were hydrolysed with alcoholic hydrochloric acid to the 8-benzylaminomethyl and 8-anilinomethyl derivatives which were converted by treating with hexamine into the 8-formyl derivative.

6-Hydroxycoumarin on similar reaction with (A) gave the 5-dimethylaminomethyl derivative which was converted into the known 5-formyl derivative. With (B) and (C) only the oxazino derivatives 2′ H-3′-benzyl-3′, 4′-dihydro-1′, 3′-oxazino-5′, 6′, 5, 6-coumarin and 2′ H-3′-phenyl-3′, 4′-dihydro-1′, 3′-oxazino-5′, 6′, 5, 6-coumarin were obtained. These were converted into 5-benzylaminomethyl and 5-anilinomethyl derivatives respectively which with hezamine gave the 5-formyl derivative.

Ethyl 7-hydroxycoumarin-3-carboxylate with formalin and with (A), (B) and (C) gave the 8-dimethylaminomethyl derivative, 2′ H-3′-benzyl-3′, 4″-dihydro-3-carboethoxy-1′, 3′-oxazino-5′, 6′, 8, 7-coumarin, and 2′ H-3′ phenyl-3′, 4′-dihydro-3-carboethoxy-1′, 3′-oxazino-5′, 6′, 8, 7-coumarin respectively.

The first two products were brominated and the bromo derivatives were found to be identical with the products obtained on reacting ethyl 7-hydroxy-6-bromo-coumarin-3-carboxylate with formalin and (A) and (B) respectively.

289. "Studies in the chemistry of the non-Fatty matter obtained from the seeds of Melia azedarach, Linn."

R. V. PATWARDHAN, V. G. SONAR and V. A. PATWARDHAN, Sangli.

Melia azedarach, Linn., known as the Persian lilac in English and as 'Bakan-nimb' or 'Himdruma' in Marathi, is a deciduous tree belonging to the botanical Family—Meliaceae, and is long known to have high medicinal value. The seeds used have been obtained from a tree in Sangli.

The non-fatty matter in the seeds was obtained after complete extraction of the fatty matter from the crushed seeds by means of diethyl ether. On analysis of the non-fatty matter by A.O.A.C. methods, the following percentage composition was obtained :—Moisture 11·65, Mineral matter (ash) 5·3, Sand and siliceous matter 0·062, crude Protein 34·9, crude Fibre 8·12 and digestible carbohydrates 40·03—(Starch 7·1 and Sugars 0·9). Ash contained iron, calcium, magnesium, potassium, sulphate, carbonate, phosphate and silicate.

The identification of the amino-acids obtained on hydrolysis of the non-fatty matter has been done by the application of circular paper chromatography. The chromatogram has shown the presence of leucine, phenylalanine, valine, tyrosine, proline, alanine, glutamic acid, serine, arginine, histidine and lysine.

The non-fatty matter was extracted with different solvents and the extracts were studied. The percentages of the different extracts were as follows : Ethyl alcohol 2·15; Ethyl acetate 1·55; Chloroform 1·36 and Acetone 1·3.

The ethyl alcohol extract showed the presence of carbohydyrates and the absence of tannins. The ethyl acetate extract showed the presence of saponins. Prollius test for alkaloidal matter indicated its presence in traces.

290. "Composition of the fatty acids obtained from the fatty oil of the seeds of Melia azedarach, Linn."

R. V. PATWARDHAN, V. G. SONAR and V. A. PATWARDHAN, Sangli.

Melia aredarach, Linn. (English : Persian lilac,—Marathi : Baykan-nimb or Himdruma) is a deciduous tree belonging to the botanical family, Maliaceae. It is

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long known to have high medicinal value. The seeds obtained from a tree in Sangli have been used for the extraction of the fatty oil. The pale yellow oil obtained to the extent of 44 per cent., was saponified and the mixed fatty acids were extracted after separation of the unsaponifiable matter. By using different methods the mixed fatty acids obtained were found to have the following percentages of oleic acid, linoleic acid and saturated acids :—

Method	Oleic acid	Linoleic acid	Saturated acids
Bromination	44·78	48·92	6·3
Urea adduct	42·17	52·56	5·3
Thiocyanogen	42·96	54·24	2·8

The composition of the saturated acids calculated from the equivalent weight is palmitic acid 3·7% and stearic acid 2·6%. The composition of the mixed fatty acids by spectrophotometric, chromatographic and other methods is being studied.

291. A study on the modification of rosin and film forming properties of the products.

SANT KUMAR and A. C. GUPTA, Kanpur.

Oleoresionous varnishes have been prepared from limed rosin, Zinc-calcium resinate, Estergum and Pentaerythritol esters and comparative film forming properties have been evaluated. Zinc calcium resinate had the highest softening point (118°C) and varnishes prepared from this product as well as from Pentaerythritol modified product gave better performance in respect of hardness test as compared to the estergum and limed rosin. Outdoor exposure tests showed the complete failure of the film of the limed rosin and zinc calcium rosinate. Pentaerythritol ester showed some durability in comparison to others.

292. Synthetic studies in the indole field. Part I: Synthesis of 7-Nitrotryptophan.

S. P. HIREMATH and S. SIDDAPPA, Dharwar.

The synthesis of 7-nitrotryptophan by two different routes is described in the paper. 7-Nitroindole prepared from ethyl pyruvate o-nitrophenylhydrazone through a Fischer cyclisation with polyphosphoric acid was converted to 3-diethylaminomethyyl-7-nitroindole, m.p. 79-80°, and condensed with acetamidomalonic ester. The resulting ethyl α-acetimido-α-carbethoxy-β-(7-nitro-3-indolyl)-propionate (A) m.p. 202-3°, on hydrolysis, decarboxylation and deacetylation gave 7-nitrotryptophan, m.p. 320°. The Warner and Moe's method for the synthesis of the above amino acid was found to be successful and gave better yields. γ-Acetamido-γγ-dicarbethoxy-n-butyraldehyde o-nitrophenylhydrazine, m.p. 40°, was prepared from acrolein, acetamidomalonic ester and o-nitrophenylhydrazine and cyclised with polyphosphoric acid in good yields to obtain the intermediate (A) required for the preparation of 7-nitrotryptophan, which is of interest as a bacterial inhibitor.

293. Behaviour of 5-Pyrazolones with Benzaldehyde and study of the infra-red spectra of the condensation products.

D. C. PATI, A. S. MITRA and M. K. ROUT, Cuttack.

5-Pyrazolones with only one reactive hyydrogen in the 4-position have been reacted with benzaldehyde and bis-hetero-cyclic compounds have been obtained. I.R. absorption spectra of the condensation products have been studied.

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294. Infra-red spectra of some heterocyclic keto-methylene compounds Part I, amide carbonyl bands, enolic bands and aromatic bands.

A. S. MITTRA and M. K. ROUT, Cuttack.

In the present investigation, a number of keto-methylene compounds have been prepared and their I.R. spectra have been studied. The following structural changes have been investigated : (1) effect of conjugation on the amid $>C=O$ band by formation of styryl compounds, (2) influence of arylation or alkylation of the $>NH$ hydrogen on the amide carbonyl band, (3) introduction of styryl group into the compounds and its characteristic frequencies, (4) effect on the enolic character of the amide $>C=O$ on formation of styryl compounds.

295. Merocyanines and unsymmetrical cyanines derived from diphenyl thiothiazoline.

B. K. SABATA, G. GHOSH and M. K. ROUT, Cuttack.

The preparatons of some merocyanines and unsymmetrical cyanines derived from diphenyl thiothiazoline are described. Comparison of their absorption maxima with those derived from 4-aryl-2-methyl thiazole indicates that these may be regarded as $n=0$ type merocyanines and unsymmetrical cyanines corresponding to $n=1$, 2 & 3 type merocyanines and ussymmetrical cyanines derived from 4-aryl-2-methyl-thiazole.

296. Merocyanines derived from substituted benzimidazoles.

P. K. MISRA, B. K. SABAT and M. K. ROUT, Cuttack.

The present work describes the preparation of substituted benzimidazole and preparation of merocarbo- and merodicarbo cyanines derived from substituted -2-methyl benzimidazoles and substituted rhodanines.

The merocarbocyanines were prepared by condensing 2-methyl benzimidazole methiodides with 5-ethoxy methylene-3-phenyl rhodanine in presence of acetic anhydride and triethylamine. The merodicarbocyanines were prepared by condensing 2-methyl benzimidazole methiodides with 5-(3-acetanilido allylidine) 3-phenyl rhodanine in presence of acetic anhydride and triethylamine.

297. Unsymmetrical cyanines derived from thiazoles and thiadiazoles.

P. B. TRIPATHY and M. K. ROUT, Cuttack.

Two series of unsymmetrical cyanines are described. The first series is derived from thiadiazole as the fixed basic nucleus and a number of basic nuclei as the variable component. In the second series, 4-p-bromophenyl thiazole is used as the fixed basic nucleus and two other nuclei as the variable basic component.

The absorption maxima of the above dyes have been determined and from the absorption data, the corresponding deviations have been calculated.

The relationship between deviation and relative basicity has been clearly brought by considering the energy level diagrams of both symmetrical and unsymmetrical cyanines.

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298. Preparation of N-2 (4-aryl thiazolyl) benzamidines for use as antitubercular compounds.

R. K. SATAPATHY, B. DASH and M. K. ROUT, Cuttack.

Several N-2-(4-aryl thiazolyl) benzamidines have been prepared by treating equimolecular quantities of different 4-aryl-2-amino thiazoles and benzo nitrile with an equivalent of sodium. These compounds are expected to possess remarkable activity against Mycobactorium tuberculosis because of their similarity to several antitubercular compounds and of their basic nature, a condition conducive to greater antitubercular activity (Robinson, J. Chem. Soc., 1940, 505).

BIOCHEMISTRY

299. Rapid determination of the reducing sugars by modified Bertrand method.

M. V. HEGDE and N. R. KALE, Poona.

The method consists of heating varying amounts of reducing sugar with excess of copper reagent in a series of special centrifuge-tubes at 98°C for fifteen minutes. The precipitate of Cu_2O formed is collected by sedimentation. Quantitative sedimentation is achieved by the addition of dilute solution of "Tween 60" as a wetting agent. After thorough washing, Cu_2O ppt is dissolved in acetic acid and copper is determined iodometrically.

The method is found to be applicable for the estimation of glucose, lactose, maltose, invert sugar galactose, mannose, arabinose and xylose, showing a linear relationship between the reducing sugar and Cu_2O ppt over a range of 2 to 15 mgms. of sugars.

300. Studies on iodine binding capacities of purified amylose and amylopectin by potentiometric method.

Miss SAROJ P. GUPTE and N. R. KALE, Poona.

Purified amylose and amylopectin were obtained by fractionating potato starch with ethanol in presence of urea. Iodine binding capacities of these products were critically determined by Rundel's potentiometric method. The values obtained for amylose and amylopectin are 19·5% and 0·27% in contrast with 19·5% and 0·45% respectively, reported by previous workers. The results indicate that the products isolated by this method are pure and amylopectin is free from traces of amylose.

301. Purification of Acid Phosphatase from Agave (cantala).

A. S. SANE and N. R. KALE, Poona.

Soluble acid phosphatase is isolated from saline extract of Agave (Cantala). Active enzyme is quantitatively precipitated on addition of acetone 50 per cent (v/v), at 0°C. Further purification with ammonium sulphate (2·2 M) gave a product of 20 fold purification with a yield of 45%. Preliminary results indicate that enzyme is a monoesterase with optimum PH 4·6 and is remarkably stable up to 60°C.

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302. "Turbidimetric estimation of serum globulins by cadmium sulphate reagent."

B. P. GHOSH, Calcutta.

1. Attempt has been made to develop a simple turbidimetric method for testing liver function by employing cadmium sulphate reagent prepared by dissolving 400 mg. cadmium sulphate in 1000 c.c. Barbitone buffer pH. 7·5 and estimating the turbidity in a Klett—Summerson photo-electric colorimeter with Filter 64.
2. The albumin/globulin ratio in serum seems to correlate with the turbidity reading with this reagent.
3. The Gamma globulin in serum increases the turbidity value.
4. A high turbidity reading in presence of a normal albumin/globulin ratio may be the indication of elevation of $Alpha_1$, $Alpha_2$ or Beta/globulin in serum.
5. A poor response is obtained with this reagent in cases where the levels of globulin fractions are either normal or low.

303. Liver ketogenesis V: In-vitro acetoacetate production and utilization in rats fed high fat-high protein diet.

J. M. KHANADE and M. C. NATH, Nagpur.

These results, in general, indicate that the metabolism of tissues in-vitro is regulated by the major source of calories in the preceding diet. Feeding of high fat-high protein diets alone or with thyroid reduce the normal growth of rats and cause hyperglycemia, fatty livers, hypertrophy of adrenals and reduction in adipose tissue weights to varying degrees. These diets induce increased acetoacetate production by liver slices without any parallel rise in its extrahepatic utilization. Influence of hormones on the relationship between ketogenesis and lipid metabolism is discussed in the light of the results presented.

304. Studies on the effect of vitamin B_{12}, unsaturated fat and glucose cycloacetoacetate on serum lipoproteins in experimental hyperlipemia.

D. M. BRAHMANKAR, K. S. MOREY, and M. C. NATH, Nagpur.

Effect of saturated fat, mixed fat and saturated fat along with Glucose Cycloacetoacetate (GCA) hydrolysed and vitamin B_{12} was studied on the serum lipoprotein fractions of the rats. Serum beta-lipoprotein fraction and beta/alpha ratio, was higher in the animals given saturated fat than those receiving same level of mixed (saturated and unsaturated) fat and the animals fed saturated fat and treated with GCA (hydrolysed) and vitamin B_{12}. It was suggested that vitamin B_{12}, GCA (hydrolysed) and unsaturated fat (present in mixed fat diet) lowered higher beta-lipoprotein level and beta/alpha ratio through hypocholesterolemic effect in experimental hyperlipemia.

305. Effect of carbohydrates on the intestinal synthesis of thiamine in rats.

M. C. NATH and S. K. MEGHAL, Nagpur.

The ingestion of as little as 10% of glucose or sucrose by rats given a thiamine-free basal diet resulted in decreases in the daily urinary and faecal excretion of thiamine and these rats ultimately died of thiamine-deficiency during the 5th week of the experiment. Hydrolysed glucose cycloacetoacetate which has already been shown to enhance the biosynthesis of thiamine, could prevent the thiamine deficiency

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in rats fed on glucose or sucrose; the daily urinary and faecal excretion of thiamine then increased and the tissue content of thiamine was higher. Pectin was also found to enhance the biosynthesis of thiamine as it favoured the growth of coliform organisms in the intestine. Coprophagy was not prevented during the experiment. Cellulose and honey did not show any significant effect on the biosynthesis of thiamine.

306. Electrophoretic study of serum lipoprotein pattern in health and metabolic disorders.

M. C. NATH and INDU VAISHWANAR, Nagpur.

The lipo-protein pattern of 69 male healthy subjects and 88 patients of different metabolic disorders have been presented by using the method of paper electrophoresis.

It is suggested from the result that in normals with age, there is an increase in serum beta-lipoprotein fraction without appreciable alteration of lipids in the alpha fraction. The rise of cholesterol in the beta-lipoprotein was accompanied with moderate increase of phospholipids in this fraction leading to slight increase of Beta-cholesterol/phospholipid ratio.

An attempt for the comparison of the normal lipoprotein pattern with patients has been made in the present study and it has been noted that the beta-lipoprotein rise was much more conspicuous with considerable decrease in the alpha lipoprotein in the patients leading to a higher beta/alpha ratio over the normals.

Cholesterol rise was much more in the beta-lipoprotein fraction than the beta-phospholipid leading to much higher ratio of C/P in this fraction above the normals of all age groups. Hence the comparison of this ratio with the normals may be taken as a better index than beta-cholesterol level alone.

307. Studies on Vitamin A: Complexes of Vitamin A with salts of fatty acids.

SUKHAMOY BHATTACHARYA, Calcutta.

An attempt has been made to prepare complexes of Vitamin A with aluminium salts of fatty acids and to study the stability of the vitamin A in the resulting products under a variety of storage conditions e.g. at an elevated temperature (50°C), at room temperature (25°-35°C) and in the cold (below 5°C).

Preliminary observations tend to show that some of the fatty acid salts, when complexed with vitamin A have got considerable stabilizing effect on the vitamin. The level of vitamin A activity in these complexes has some bearing on the stability of the vitamin.

308. On the Problem of Controlled Hydrolysis of Nucleic Acid.

S. PAL and S. K. DUTTA, Calcutta.

Controlled non-enzymatic hydrolysis of nucleic acid as a method of cleaving long polyribonucleotide chains into discrete units of a size amenable to sequence and end-group determination is still a problem. Complete breakdown of nucleic acid (RNA) into its purines, pyrimidines, sugar and phosphate has been achieved by many workers (Levene, J. Biol. Chem (1922), *53*, 441, Chargaff *et al*, J. Biol. Chem. (1948) *176*, 715; Hotchkiss, J. Biol. Chem. (1948), *175*, 315, Marshak *et al*, J. Biol. Chem. (1951) *189*, 597). All these methods have some limitations when quantitative microestimation of the free bases have to be carried out. Attempt

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has been made to use trifluoro-acetic acid for controlled hydrolysis of nucleic acid, the observations of which were recorded. Studies on the nucleotides as well as on the free nitrogenous bases with anhydrous as well as hydrated trifluoroacetic acid under different conditions have also been made. Simultaneous liberation of free purines and pyrimidines from RNA with this acid was found complex. The problem has been discussed.

309. Purification and properties of Glucose-6-phosphate Dehydrogenase from rice seedling.

R. K. MANDAL and ASOKE G. DATTA, Calcutta.

Glucose-6-phosphate dehydrogenase (Zwischen ferment) has been purified twentyfive folds from extracts of 48 hours old rice seedling coleoptiles by ammonium sulphate fractionation and adsorption on calcium phosphate gel. The enzyme is active only with TPN and not with DPN. It contains some 6-phosphogluconate dehydrogenase activity. The enzyme shows no requirement for added Mg++. Its optimum pH is 7·6. The Michaelis constant is $2{\cdot}8\times10^{-4}$ M for glucose-6-phosphate.

310. Isolation of a Low Molecular Weight Ribonucleic acid from Brain Nuclei.

SUBIR K. CHANDA and J. J. GHOSH, Calcutta.

A low molecular weight ribonucleic acid (RNA) fraction has been isolated from goat brain nuclei, by making use of the solubility in 2M NaCl. RNA, thus isolated was hydrolyzed in 0·3M KOH for 20 hours at 37°C to the individual mononucleotides, which were further analyzed by paper chromatography. Both guanylic and cytidylic acid content were found to be significantly higher than adenylic acid and uridylic acid content. In this respect, this RNA preparation from goat brain nuclei has some similarity to the low-molecular weight RNA preparations from *B. coli*, yeast and other sources. The ultra violet absorption properties of the RNA preparation has also been studied.

311. Effect of Vitamin B_{12} deficiency on the ammonia metabolism in rat brain.

(Miss) DIPALI BHATTACHARYA and J. J. GHOSH, Calcutta.

Vitamin B_{12}, like all other members of the B-complex group, plays an important part in the normal functioning of brain tissues. Very little is known on the role of vitamin B_{12} in protein and amino acid metabolism in brain. Comparative studies were made using whole brain homogenates as well as cortex slices from normal and vitamin B_{12} deficient rats regarding ammonia formation. It has been found that zero hour ammonia level is not much affected in vitamin B_{12}—deficient rat brain in comparison to that of normal. The ammonia suppressing effect of glucose, which is very prominent in normal brain tissues, is completely absent in brain tissues of vitamin B_{12} deficient rats.

312. Some properties of 18,20-dioxygenated steroids.

P. K. BHATTACHARYYA, B. D. KULKARNI, D. D. GODSE and MANSA RAM, Poona.

The proximity of the angular methyl carbon 18 and the side chain carbon 20 in steroids causes some interesting steric interactions. These are particularly mani-

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fested in some 18,20-dioxygenated steroids obtained by partial synthesis from the "kurchi" alkaloids.

3β, 18, 20α-Trihydroxy-5-pregnene obtained in three stages from holarrhimine involving nitrous acid reaction, boron-trifluoride-acetic anhydride cleavage of the resulting 18-20β oxido products and hydrolytic deacetylation gave back a 18-20 β oxido compound on sublimation.

18-Hydroxyprogesterone, 11α, 18-dihydroxyprogesterone and 18-hydroxy-3 β-acetamido-20-oxo-5-pregnene (I) obtained from holarrhimine were found to exist almost exclusively in the 18-20 hemiketal form. Compound I on lithium aluminium hydride reduction gave the 18, 20α-ether instead of the expected diol.

Progesterone-18-carboxylic acid and its 11α-tosyloxy derivative were insoluble in bicarbonate and existed in stable 18-20 lactol forms. In contrast 3 β, 20 α diacetamido-5-pregnene-18 carboxylic acid behaved like a true carboxylic acid.

18-Hydroxy-3 β-N dimethyl-20-oxo-5-pregnene was prepared in two forms from conessimine, one (IIa), melting at 74° and the other (IIb) at 89°. Most of the physico-chemical properties including optical rotation and IR spectra of both these forms were identical. On reduction with lithium aluminium hydride IIa and IIb yielded two diols, (IIIa and IIIb), having melting points 165° and 146° respectively. These two diols were indistinguishable in their optical rotation and their solid-state IR spectra which indicated strong intramolecular hydrogen-bonding. On pyrolysis, however, they yielded two distinctly different carbonyl compounds by an unusual intramolecular hydride transfer reaction.

313. Adsorption of dyes by bacteria.

S. V. SOMAN, Nagpur.

The adsorption of dyes like crystal violet, saffranin, eosine, rhadamin B, and substances like sulphanilamide and iodine by organisms like *B. subtilis* and *E. coli* was investigated.

The washed experimental organisms were suspended in water to yield a resting cell suspension of desired bacterial count. The amount of the dye adsorbed by suspensions containing the resting cells, the heat killed cells and the acetone washed cells was investigated. Following conclusions were drawn from the above set of experiments.

(1) When the dye is adsorbed by intact bacterial cells the adsorption isotherm has a sigmoid shape.

(2) At higher concentrations the adsorbate appeared to form a multimolecular layer on the bacterial surface, suggesting a co-operative adsorption.

(3) When the permeability barrier of bacteria was destroyed killed the cells at 70°C or washing them with acetone the shape of the adsorption isotherm was found to be of the Langmuir type.

(4) From many other instances found in literature it was inferred that the Langmuir type of adsorption isotherm results when the adsorbate and the entire bacterial protoplasmic mass interact and are in true equilibrium, whereas a sigmoid isotherm results when the interaction takes place between the adsorbate and only the bacterial surface.

314. Microbiological transformations of terpenes. III—Transformations of some mono- and sesquiterpene hydrocarbons by *aspergillus niger*.

P. K. BHATTACHARYYA, B. R. PREMA, R. S. DHAVALIKAR and B. V. RAMACHANDRAN, Poona.

The microbiological transformation of α-pinene to verbenol, verbenone and trans sobrerol by *Aspergillus niger* has been established. In continuation of

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these studies α-santalene, camphene, longifolene, β-santalene, carane, Δ^3-carene and humulene were subjected to microbiological oxidation with *A. niger*.

α-santalene yielded tere-santalic acid, $C_{10}H_{14}O_2$ (m. 152-54°; n. equiv.=164; $[\alpha]_D$ (−)72° (benzene) in about 25 per cent yield along with small amounts of the corresponding alcohol *tere*-santalol, $C_{10}H_{16}O$ (m. 112-114°C) by fermentation with *A. niger*.

Under the same conditions, camphene, longifolene and β-santalene yielded the identical dicarboxylic acid which could be isolated only as the liquid anhydride, $C_{11}H_{16}O_3$, in maximum yields amounting to 30%, 40% and 35% respectively. The anhydride was characterized as hexylidine methyl succinic anhydride through its physico-chemical properties, degradation, and eventual synthesis by two independent routes.

Carane, Δ^3-carene and humulene proved to be rather resistant to transformation by the experimental strain of *A. niger*.

315. Investigation of the oil from the seeds of Garcinia Xanthochymus.

B. K. SABATA and M. K. ROUT, Cuttack.

In the present investigation, the percentage composition of the mixed fatty acids of Garcinia Xanthochymus seed oil has been determined by two methods, (1) methyl ester fractionation, (2) stepwise addition of urea.

The results with regard to composition obtained from both the methods are indicated below :—

	Methyl ester fractionation method	Urea adduct method
Palmitic acid ...	... 40·3%	41·0%
Oleic acid ...	... 55·9%	55·5%
Linoleic acid ...	... 3·8%	3·5%

316. Factors influencing the Distribution of Zinc—65 in albino rats.

S. BRAMANANDAM, B. NAGARAJAN and V. M. SIVARAMAKRISHNAN, Madras.

In continuation of our investigations on Cobalt-60 (vide Proc. Ind. Sci. Congr., 1960 & 1961), we have studied the effects of time, of increasing concentrations of various chelating agents, and of inert zinc-carrier on the distribution of Zinc-65 in albino rats. The tracer, injected alone, is deposited mainly in the liver, the bones, the skin and the muscles like Cobalt-60, but the excretion is comparatively slow and mainly faecal unlike cobalt-60 which is rapidly excreted through urine. The distribution is progressively altered by increasing concentrations of the chelating agent used; and with enough chelating agent, it is possible to produce a high localization of zinc-65 in the lungs by oxine and 2-methyloxine (about 60%) and in the liver by sodium diethyldithiocarbamate and rubeanic acid. Ethylenediaminetetraacetic acid considerably enhances the excretion, the chelate exhibiting a marked apathy for the liver, being preferentially deposited in the skin and the bones. All these changes are quite similar to those on cobalt-60. This suggests that provided a firm chelate is formed and the metal is at the tracer level, it may be the chelating agent rather than the metal that decides the specific tissue of preferential localization. Simultaneous administration of carrier-zinc, with the tracer or with the tracer plus the chelating agent, delays the tissue-deposition of radio-activity from the vascular compartment.

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317. Search for potential filaricides.

A. B. SEN and K. SHANKER, Lucknow.

Fourteen carboalkoxybenzenearsonic acids and carboalkoxystibinic acids have been prepared. The required esters were obtained from p-aminobenzoic acid and p-aminosalicylic acid by esterification with n-propyl-, n-butyl-, isobutyl-, and n-hexyl alcohol. These esters were then converted into the arsonic acids by the Scheller-Bart reaction (C.A., *34*, 1632) and into stibinic acids by Bart-Schmidt reaction (J. Chem. Soc., 1930, 1937).

318. Influence of different acids on the lost activity of Yeast Invertase due to Ag+-ions.

M. M. BISWAS, Calcutta.

Activity of 50 c.c. of a 2% solution of vacuum dried yeast invertase was at first inhibited by 5 c.c. $\frac{N}{10}$ $AgNO_3$ solution. Invertase activity was measured by the concentration of reducing sugar formed by hydrolysis of 80 gm. sucrose by 50 c.c. 2% invertase solution in presence of 25 c.c. 10% Na_2HPO_4 solution in an incubator. 2·5 c.c., 5 c.c., 7·5 c.c., 10 c.c. and 15 c.c. volumes of $\frac{N}{1}$ HCl, $\frac{M}{1}$ phosphoric acid and 10% nucleic acid suspension in water were used in the activation experiments. Corresponding values of activity were 2·77 gm., 7·81 gm., 12·50 gm., 20·83 gm. and 41·66 gm with $\frac{N}{1}$ HCl., 2·31 gm., 5·68 gm., 15·62 gm., 17·85 gm. and 31·25 gm. with $\frac{M}{1}$ phosphoric acid and 0·80 gm., 1·04 gm., 1·66 gm., 1·92 gm. and 2·08 gm. with 10% nucleic acid. Activity figures for the three acids viz. $\frac{N}{1}$ HCl, $\frac{M}{1}$ phosphoric acid and 10% nucleic acid suggest that revival is highest with $\frac{N}{1}$ HCl., less with $\frac{M}{1}$ phosphoric acid and least with 10% nucleic acid. Increase of activity due to acids also corroborates the theory of displacement of Ag+ ions in the reactivation process.

INDUSTRIAL AND APPLIED CHEMISTRY

319. Electrolytic preparation of Uramil and diphenyl acetic acid.

H. P. AGARWAL and (Miss) S. L. KAPOOR, Bhopal.

The 5-nitro-barbutaric acid on electrolytic reduction at 60°C in 30% sulphuric acid, gave uramil using a current density of 3 milli amp./sq. cm. Similarly at room temperature benzillic acid in 10% solution of sulphuric acid is reduced to diphenyl acetic at a current density of 15 milli amp/sq. cm. The percentage yield in the former case is 50% and in the latter 53%. For greater yield the electrolysis will have to be prolonged for a longer duration than the theoretically calculated time.

In both the cases, the reduction was brought about in a cell in which catholyte was separated from anolyte by means of a fritted glass diaphragm. A copper foil served as cathode and a platinum foil as anode. The method can be extended for preparation of similar other compounds.

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320. Miscella refining of castor oil.

R. R. GUPTA, K. N. AGRAWAL and A. C. GUPTA, Kanpur.

The refining of Castor oil in the miscella stage has been studied in the Laboratory. It was observed that about 50% miscella concentration and 3 to 9% alkali solution gave optimum results in respect of final F.F.A., colour and recovery of the oil. 2% excess alkali was found to be sufficient for neutralization to produce oil of 0·1 F.F.A. 0·3% aqueous solution of citric acid was used for final washing. The separation of soap in the miscella was quick and clear and it was found possible to separate it without using a third solvent. Centrifuging could also be used with advantage for separation of soap and miscella.

321. Kasipatnam Vermiculite.

ABDE ALI and T. R. BETARAYA, Hyderabad.

The vermiculite of Kasipatnam occurs along the margins of the apatite rich pegmatite and magnetite, in a valley about 5 miles from Kasipatnam, Vizianagaram Taluq, Visakhapatnam district, Andhra Pradesh. The properties studied and the tests made on the mineral were chemical and mineral analysis by X-rays, petrographic examination and differential thermal analysis; behaviour under Heating Microscope; specific gravity; hardness; treatment with some chemical agents and exfoliation. The results indicated that the material was an intermediate product resulting from the hydrothermal alteration of biotite and consists of unchanged biotite, hydrous mica and vermiculite. The suitability of this material for thermal insulation was ascertained by compounding the processed vermiculite in two sizes with varying amounts of Srirangapur clay and subjecting the previously fired test specimens to the following tests : drying, firing, and reheat shrinkages, apparent porosity, specific gravity, bulk density, water absorption, crushing and tensile strength and thermal conductivity. The data obtained showed that by the use of improved method of forming and subsequent heat treatment the vermiculite bodies can be fabricated suitable for thermal insulation up to 2000°F, product confirming to A.S.T.M. reheat tests.

322. Catalytic synthesis of iso-butyric acid from isopropanol and carbon monoxide at high pressure.

E. L. BAPTIST, S. N. NAG and S. K. BHATTACHARYYA, Kharagpur.

The synthesis of isobutyric acid from isopropanol and carbon monoxide has been studied in presence of nickel iodide silica gel catalyst, at a temperature, 180-300°C, and a pressure, 2000-6000 p.s.i.

A maximum process yield of 20·8% isobutyric acid based on isopropanol was obtained under the most favourable conditions (temperature=245°C, pressure=4400 p.s.i., residence period=2 hours and mole ratio of propanol and carbon monoxide =1 : 2·47) using a silica gel supported nickel iodide catalyst containing 84·1% NiI_2. The yield of isopropyl isobutyrate under those conditions was 12·7% based on isopropanol.

Addition of water to isopropanol enhanced the yield of acid at the cost of ester. Under the above mentioned conditions the maximum yield of isobutyric acid and isopropyl isobutyrate were 24·12% and 9·83% respectively when a solution of isopropanol in water containing 27·3 mole per cent isopropanol was used.

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323. Catalytic synthesis of pivalic acid from tertiary butylchloride, water and carbon monoxide under high pressure.

G. B. PUROHIT, S. K. PALIT and S. K. BHATTACHARYA, Kharagpur.

A systematic study on the synthesis of pivalic acid from tertiary butylchloride, carbon monoxide and water was carried out in the presence of nickel iodide silica gel (Ni : Si=50 : 50) catalyst under ranges of, pressure, 4200—5200 p.s.i., temperature 208°—290°C and residence period 2-4 hours. The main liquid products of the reaction were found to be pivalic acid and tertiary butyl ester of pivalic acid. Tertiary butyl alcohol was also found to be present in small quantities. An experiment without adding water as a reactant was carried out and very little ester was found to be produced.

Under the optimum conditions of pressure 4800 p.s.i., temperature 262°C, residence period 3 hours and catalyst volume 5 c.c. the maximum process yields of acid and ester on the basis of input tertiary butyl chloride are 16·55% and 13·75% respectively in the presence of nickel iodide silica gel ($Ni : SiO_2 = 50 : 50$) catalyst when the mole ratios of the chloride, water and carbon monoxide are 1 :6 :9·4.

324. Synthesis of methyl acrylate from acetylene, carbon monoxide and methanol under pressure.

A. K. SEN and S. K. BHATTACHARYYA, Kharagpur.

The present paper deals with the systematic studies on the synthesis of methyl acrylate using acetylene, carbon monoxide and methanol. Various catalysts have been tried but nickel iodide-silicagel ($Ni : SiO_2 : : 50 : 50$) was found to be the most active.

A maximum process yield of 46·82% based on acetylene was obtained using 5 c.c. of nickel iodide-silicagel catalyst ($Ni : SiO_2 : : 50 : 50$) at a reaction pressure of 35 atm., temp. of 190°C, residence period of 4 hours, and with a mole ratio of acetylene : carbon monoxide : methanol as 1 :1 :4·7.

The maximum yields of methyl acrylate with cobalt and iron iodide on silicagel catalysts were much less than that obtained with nickel iodide on silicagel catalyst.

325. Catalytic production of butadiene from ethyl alcohol by single stage.

B. N. AVASTHI, N. D. GANGULY and S. K. BHATTACHARYYA, Kharagpur.

One-step catalytic conversion of ethyl alcohol to butadiene has been exhaustively studied. The present paper embodies the results of investigations under the following heads :

I. Synthesis of butadiene in the fixed bed flow reactor in presence of a large number of single, binary and ternary oxide catalysts systems, totalling to 156 in number.

II. Synthesis of butadiene in a fluidised reactor in presence of catalyst systems, found to be active in the fixed bed operation.

III. Studies on the physico-chemical properties of the promising catalysts by the applications of Differential Thermal Analysis Technique (D.T.A.) and surface-area measurements and hence the correlation of the structural characteristics of the catalysts with their activity.

The influence of operating variables like temperature, feed rate, catalyst weight, method of catalyst preparation, water content of the ethanol feed, deactivation and reactivation of the catalysts, etc., was thoroughly and systematically studied both in the fixed as well as in the fluidised beds.

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I. Of the fifty one single oxide catalysts, MgO, ThO_2 and ZrO_2 were found to be the most active. Using these catalysts, the maximum process conversions of alcohol to butadiene were 27·43, 36·02 and 35·49 per cent respectively under optimum conditions.

Sixty five binary oxide catalysts having different compositions were tested for their activity.

Al_2O_3-ZnO (60 :40) was found to be the best among all the catalysts tried. Using this catalyst, the maximum process conversion of ethanol to butadiene was 55·83 per cent at a temperature of 425°C and ethanol feed rate of 1·875 cc/hr/gm of catalyst.

Other promising binary catalysts were Al_2O_3—MgO (80 :20), $Al_2O_3-Fe_2O_3$ (60 :40), $Al_2O_3-Cr_2O_3$ (60 :40) and $ZrO_2-Fe_2O_3$ (40 :60). Using these catalysts, the maximum process conversions were 47·76, 37·70, 47·23 and 39·66 per cent respectively under optimum conditions.

The ternary catalysts (40 in number) in general showed poor catalytic activity.

II. Only those catalysts, which were found active in the fixed bed synthesis of butadiene, were tried in the fluidised condition.

The process conversions of ethanol to butadiene using the different catalysts under optimum condition in the fluidised bed reactor are given below and compared with those in the fixed bed.

Catalysts	Fluidised bed	Fixed bed
Al_2O_3	25·95%	23·98%
Fe_2O_3	25·66%	22·31%
ZrO_2	34·22%	35·49%
ThO_2	25·42%	36·02%
Al_2O_3-ZnO (60 :40)	72·89%	55·89%
Al_2O_3-CaO (60 :40)	28·83%	28·68%
Al_2O_3-MgO (80 :20)	35·26%	47·76%
Al_2O_3-Cr_2O_3 (60 :40)	34·74%	47·23%

III. Differential thermal analyses were done for the following systems :

(i) Single oxide catalyst system—MgO, SiO_2, Al_2O_3

(ii) Binary oxide catalyst system—Al_2O_3-MgO, Al_2O_3-ZnO $Al_2O_3-Fe_2O_3$

The thermal characteristics of the catalysts, as observed by D.T.A., were substantiated by surface area measurements by B.E.T. method.

Besides the above systems, the D.T.A. data for ThO_2, ZrO_2 $Al_2O_3-Cr_2O_3$ etc., reported earlier by Bhattacharyya and his school, were successfully correlated with their catalytic activity.

The salient features of the thermograms and their relations with the catalytic activity have been discussed in the paper.

326. Solvent Retentivity Experiments with Sugarcane Wax and Its Modified Derivatives.

S. BOSE and A. N. SHRIVASTAVA, Kanpur.

In order to make sugarcane wax suitable for use as hard wax in shoe polishes, it was de-ashed, defatted and bleached with chromic acid. The resulting refined wax was condensed separately with cellosolve, ethylene glycol, glycerol, mannitol, sorbitol, ethanolamine and ethylene diamine. Melting point, acid value and hardness of the modified derivatives were determined. Hardness was measured with Penetrometer. The m.p. and hardness value were found to be highest in the case

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of ethylene diamide wax; it was further indicated that hardness value of wax gradually increased after purification and modification.

Solvent retentivity of the different wax derivatives was determined by preparing their gels with turpentine oil (b.p. 160-170°). Modified waxes when used alone, possess a very poor solvent retentivity. When the wax and solvent ratio was 3 :7, cellosolve and glycerol ester showed highest solvent retentivity. When the ratio was 1 :4 all the gels were very soft and the gel containing crude cane wax did not set at all. Highest solvent retentivity under this condition was that of glycol ester wax. Using modified wax, paraffin wax (m.p. 58°) and solvent in the ratio of 1 :2 :7, the glycerol ester wax showed highest solvent retentivity and the surface, was quite smooth and shining. Gel, containing modified wax, paraffin wax and solvent in the ratio 2 :1 :7, showed good setting characteristic but in general solvent retentivity was rather poor. It is concluded that glycerol ester wax is the best available modified wax. Shoe polish samples prepared from it had better solvent retentivity than those prepared from other modified derivatives. Polish containing glycol ester wax also possesses same solvent retentivity but the surface is not so smooth and shining as that of blend containing glycerol ester wax. Polish cake containing glycerol ester wax sets well but its consistency is found to be rather soft. The firmness may be achieved by varying the proportion of hard wax and soft wax constituents in the blend or by addition of metallic soaps such as zinc and aluminium stearate.

327. Investigation of the composition of the fatty acids of the seed oil of *Butea frondosa* by urea-adduct method.

L. SARANGI, K. K. PATNAIK, M. K. ROUT, Cuttack 3

In the present work, attempts have been made to explore the suitability of urea-adduct methods for determination of the composition of the mixed fatty acids of the seed oil of *Butea frondosa*. The results of our investigations indicate that these methods can be effectively used for separation and identification of the different component fatty acids if the experimental conditions with regard to the amounts of urea, the solvent and that of the mixed fatty acids used are properly adjusted.

328. Activation of slag with lime or clinker.

S. K. CHOPRA and KISHAN LAL, Roorkee.

Activation of slag with small quantities of lime or Portland cement clinker has been studied. Early strengths of the wet mixes of ground slag (97·5 to 90 per cent) and lime or clinker (2·5 to 10·0 per cent) were taken as an index of activation (or hydraulicity). The hydrated mixes were examined for the identification of the cementitious phases.

The strength development is of the same order with either of the two activators. Poorly crystalline calcium silicate hydrate (I) tetra-calcium aluminate hydrate, and a hydrogranet are the main hydration products formed on the hydration of the either mix. Unreacted lime is present in mixes originally containing lime more than 5 per cent. On the other hand no lime is present in clinker slag mixes. Since the clinker contains only 42 per cent 3 CaO. SiO_2 and free lime for activation is released only through its hydration, it would appear that compared to lime-mixes the corresponding clinker-mixes contain a much lower quantity of lime available for activation. But the strengths being practically of the same magnitude, it may be inferred that the intrinsic strengths of the cementitious phases formed in the two series are probably different.

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329. "Fatty acid esters of Sucrose from molasses as detergents."

M. V. KALE and K. K. DOLE, Poona 4.

Sucrose fatty acid esters have been synthesized by trans-esterification between sucrose and fatty acid esters of volatile alcohols. The sucrose monoesters are excellent non-ionic detergents and emulsifying agents. They are found to be non-toxic and non-irritant and are easily assimilated in the human system.

Molasses contain 35 to 40 per cent of unrecovered sucrose. Refined molasses is esterified by trans-esterification method to obtain sucrose mono—and di-esters using an alkaline catalyst. Sucrose mono—and di-stearates are preapred and identified. Work of preparing other fatty acid esters, improvement in the technique of the reaction and assessing the detergent and surfactant properties is being continued. Possibility of using dried molasses for esterification directly and better and cheaper methods of refining of molasses is also being investigated.

330. Studies in the Molecular Weight of Dehydrated Castor Oil.

S. G. GOGATE and K. K. DOLE Poona 4.

It has been observed in previous investigation that polymerization of DCO is influenced by the catalyst used in the dehydration process. Intermolecular and intramolecular reactions take place and consequently the type of polymerization varies. In intramolecular polymerization, decrease in iodine value takes place quite rapidly but molecular weights do not show proportional increase. In intermolecular polymerization, the drop in iodine value is proportional to the increase in molecular weight. This leads one to investigate the molecular weights of DCO samples Polymerized and unpolymerized quite thoroughly. Therefore, molecular weights of DCO samples have been studied in the present investigation by two different methods :—

(1) Cryoscopic Method;
(2) Viscosity Method.

Molecular weights determined by these two methods of the same sample of DCO show some variation. The molecular weight as determined by viscosity method shows large value than the one determined by cryoscopic method. More the polymerization of DCO sample, more is the difference in these values of molecular weights. The study of causes of this difference in molecular weights is in progress.

331. Polarity-finder for dry storage batteries.

U. H. NARAYANAN, Karaikudi.

An instrument for the detection of polarity of dry storage batteries has been designed and fabricated employing an electrometer circuit with a Philips 4067 tube. The output of the electrometer circuit is suitably amplified to drive a centre zero d.c. microammeter. The direction of deflection in the microammter shows the correctness or otherwise of pole markings. Furthermore, any short-circuiting of the formed plates inside the battery can also be detected as it would cause a null deflection in the indicating meter.

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332. Urea Fractionation of Linseed Oil Fatty Acids: A comparative study by cumulative and elution methods.

T. N. MEHTA and M. S. MURTHY, Nagpur.

The fatty acid composition of linseed oil was determined by two urea fractionation procedures. A simple cumulative urea fraction procedure was found to give results similar to those obtained by urea adduct elution method. Compositions calculated by these methods agree fairly well with the compositions given by other workers.

333. Industrial applications of clay mineralogy.

V. S. RAMCHANDRAN, Roorkee.

In the field of clay mineralogy attention has mainly been directed to the identification and estimation of clay mineral components of various clays by techniques like X-ray diffraction, electron microscopy, staining, differential thermal, thermogravimetric and infrared analyses. Only recently has the practical utility of basic research in clay mineralogy been realised.

Since the physical and chemical properties of clay materials are mainly dependent on the structure, composition and properties of clay minerals a knowledge of clay mineralogy is essential in industrial practice where clays are involved.

A few of the applications of clay mineralogy include ceramics, catalysis, constructional engineering, petroleum industry, foundry, paper manufacture, lubricant & plastic industry and agriculture.

Clay mineralogy may find application in unexpected fields. For example, the type and content of the clay mineral will indicate its usefulness for disposing off hot undesirable isotopes from nuclear reactors. The mineralogical composition of a clay would be an important factor for assessing its suitability for the manufacture of clay lightweight aggregates. A quantitative determination of the clay minerals in brick clays will provide an accurate estimation of the thermal efficiency of kilns.

334. Limiting Dephosphorisation of Iron-Phosphorus Alloys in Hydrogen at 1000°C.

B. CHATTERJEE, Howrah.

In continuation of our work on the limiting dephosphorisation of Alloys in Hydrogen, the removal or otherwise of phosphorus from an Iron-Phosphorus alloy (1·94% P) as also from the Iron-Phosphide separated from this alloy using electrolytic method (citrate cell) has been studied. The effect of particle-size of the alloy on the dephosphorisation reaction has also been investigated. No dephosphorisation could be observed on annealing this Iron-Phosphorus alloy in flowing hydrogen containing 1·2 per cent by volume of moisture for 10 hours at 1000°C. The phosphorus content of the alloy did not show any reduction on treatment with moist hydrogen at 1000°C even when the surface area of the powdered alloy was increased 5·72 times by decreasing the particle-size. This observation indicates that diffusion of hydrogen into and of phosphorus out of the alloy does not seem to play a very marked role on the dephosphorisation reaction under study. The phosphide (15·1%P) separated from this alloy, on the other hand, have been found to suffer considerable dephosphorisation on annealing in moist hydrogen at 1000°C. These results support our previous observation, viz., if the phosphorus content of the alloy is below 2%, dephosphorisation of the alloy by hydrogen at 1000C is rendered very difficult and that dephosphorisation takes place in the phosphide phase.

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335. Comparative study of the catalytic esterification of saturated carboxylic acids with ethylene at high pressures.

C. R. LAHIRI and S. K. BHATTACHARYYA, Kharagpur.

The reactions involving the esterification of acetic, propionic and n-butyric acids with ethylene have been studied in a static reactor at a temperature, 150 to 215°C and a pressure, 50–300 atmospheres, using suphuric, hydrochloric, hydroiodic phosphoric acids, anhydrous zinc chloride and ion exchange resin as catalysts. Sulphuric acid has been found to be superior to other catalysts studied. The yields of ethyl esters of the above acids under optimum conditions using sulphuric acid as a catalyst are given as follows :

	Temp., °C	Maximum pressure, atm.	Residence period, hr.	Mole ratio of ethylene to organic acid	Yield % ester
Ethylacetate ...	170	85	3	3·09	38·12
Ethylpropionate ...	170	130	3	7·33	28·67
Ethylbutyrate ...	185	136	3	6·64	28·42

336. Acid activation of inert clays and conversion to insecticidal substances.

K. KRISHNAMURTHY, S. GODAVARIBAI and S. K. MAJUMDER, Mysore.

ACID activation of kaolinic, montmorillonitic and Illitic clay samples resulted in insecticidal substances. Kaolinic clays were more insecticidal than the other clays. Comparatively, H_2SO_4 activation resulted in better insecticidal property than HCl activation. Post-activation heat treatment of the samples at 110 and 400°C showed that the insecticidal activity of the materials was considerably enhanced with the latter. Heat treatment alone did not induce permanent insecticidal activity of the clays. Acid activation was found to be essential for inducing permanent activity. Methylene blue absorption decreased and oil-bleaching properties increased of the clay progressively with the activation treatment with higher levels of acid, longer time and increased pressure, during activation and drying at 110°C.

337. On the study of indirect application of radioactive nuclei in analytical chemistry. Part IV.

B. C. PURKAYASTHA and A. K. DAS, Calcutta-9.

In a previous communication it has been shown that through indirect method of analysis by radioactive nuclei, elements of γ order of magnitude can be estimated with a fair degree of accuracy. In the present investigation estimation of palladium as PdI_2 has been undertaken using I^{131} as a measuring indicator. The principle empoyed in such estimation is as follows :—Excess of Iodine (double or three times the theoretical amount as required by the equation $Pd^{++} + 2\,I \rightarrow Pd\,I_2$) as KI containing I^{131} is added to unknown palladium in slightly acid solution. The trace of PdI_2 is co-precipitated along with zirconium phosphate. From the loss in activity of I^{131} in the filtrate the amount of palladium present can be computed. Palladium ranging from 1×10^{-3} gms to 1×10^{-6} gms has thus far been estimated within a fair degree of accuracy. The method can be claimed to be very rapid and dependable. Mechanism of uptake of PdI_2 by zirconium phosphate is under investigation. This

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study gives further supports to our previous finding published elsewhere that choice of a selective co-precipitating agent may also enable us to estimate any element present in such a trace amount (10^{-6} gms) by radiometric procedure.

NUCLEAR CHEMISTRY

338. Deposition of radioactive tracers on preformed ionic precipitates : Part V—Adsorption of Orthophosphate ions on ignited strontium sulphate.

K. R. KAR and M. M. BHUTANI, Delhi.

In continuation of an investigation, undertaken in this laboratory, on the deposition of radioactive tracers on preformed micro crystalline solids, the carrying of carrierfree orthophosphate ions ($P^{32}O_4'''$) by ignited strontium sulphate has been studied. The deposition of the radionuclide has been examined under three aspects, viz., (i) instantaneous deposition, in the absence as well as presence of the added lattice and certain nonlattice ions, as a function of pH values of the aqueous suspension medium; (ii) instantaneous adsorption as a function of the concentration of the lattice and certain nonlattice ions, the pH of the suspension medium remaining constant; (iii) carrying as a function of the time of contact of the radionuclide with the carrier surface, under various experimental conditions.

The dominant roles of pH, lattice and various nonlattice ions and also the influence of time of contact of the tracer in influencing the deposition process, have been borne out by the experimental results. On the basis of the observed facts, the carrying process has been postulated to be due to surface adsorption, in all probability, by the counter ion exchange mechanism.

339. On the study of indirect application of radioactive nuclei in analytical chemistry. Part III.

B. C. PURKAYASTHA and A. K. DAS, Calcutta.

In a previous communication application of co-ordination compounds to extend the use of I^{131} an easily available isotope of convenient half life, in the determination of mercury and cadmium was reported. Present study deals with further extension of the work to the determination of bismuth. The principle employed is to add excess of oxine and iodide mixture labelled with I^{131} to a slightly acidic solution containing bismuth and to measure the activity of a portion of the solution with a liquid counter. The loss in activity is a measure of the amount of bismuth present on the assumption that bismuth is precipitated as $(C_9H_7ON)H(BiI_4)$ under experimental conditions.

Bismuth from 10 mg. to 0·05 mg. has thus far been estimated. The data lies always within statistical fluctuations. It can be claimed to be a very quick and reliable method even in very small concentration as mentioned above.

340. Studies on RNA synthesis in *Azotobacter vinelandii* I. Distribution of P^{32} in the Ribonucleic acids of *Azotobactor vinelandii* labelled in vivo.

R. K. MANDAL and D. P. BURMA, Calcutta.

Intact cells of *Azotobacter vinelandii* readily incorporates P^{32} as inorganic phosphate into RNA when incubated in presence of an energy source like sucrose. When the cells labelled *in vivo* are disintegrated and subcellular fractions are

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separated by differential centrifugation, the particulate fractions are found to be labelled many times more than the soluble supernatant. Isolation of the P^{32}-labelled RNA by phenol followed by its gradient elution chromatography on DEAE-cellulose anion exchanger also confirms the idea that in intact cells, particulate RNA is synthesised first which may subsequently find its passage into the soluble fraction.

341. Mass-spectral analysis of Tetramethyl lead.

J. SHANKAR, M. R. GHATE and K. N. BHIDE, Bombay.

The cracking patterns of tetramethyl and tetraethyl lead have been studied at various ionizing voltages with the type 21-103C CEC mass-spectrometer. Suitable conditions for the isotopic analysis of lead have been discussed.

342. Isotopic exchange in the cobaltous-cobaltic system: (II) Heats and entropies of exchange.

J. SHANKAR and B. C. deSOUZA, Bombay.

The thermodynamic quantities for two paths present in this system as shown previously by the authors, have been evaluated. For the acid independent path, the ΔH and ΔS values have been found to be $12{\cdot}6 \pm 0{\cdot}5$ Kcals and -14 ± 2 eu. respectively, while those for the acid dependent path were $11{\cdot}6 \pm 2{\cdot}5$ Kcals and -11 ± 7 eu. The first hydrolysis constant of the cobaltic ion has been found to be $11{\cdot}7 \times 10^{-3}$f at 0°C. The value of ΔH and ΔS were found to be 11 ± 3 Kcals and 29 ± 11 eu. The ionic strength was maintained at 1·0 throughout.

343. Recoil effects of cobalt-60 in (n, γ) reactions in tris acetylacetone Co (III) diluted with tris acetylacetonerhodium (III).

J. SHANKAR and MANOHARLAL, Bombay.

Studies on the (n, γ) reaction in tris acetylacetone cobalt (III) diluted with isomorphous rhodium complex are described in this paper. Compared to the undiluted cobalt complex, these studies reveal a lowering of initial retention on dilution. Similarly in thermal annealing studies, the diluted samples show lower saturation values ($R\infty$), even though the annealing rates are faster. In all these experiments, dilution with the rhodium complex has a less pronounced effect than with the aluminium complex.

344. Uranium-232 build-up in converter reactors (Part I—Thermal neutron irradiation).

HARI SINGH, V. K. SUNDARAM and D. V. GOPINATH, Trombay.

When thorium is irradiated with neutrons in converter reactors, certain amount of uranium-232 is also formed along with the fissile material uranium-233. Uranium-232, having 74 years half-life and a long chain of short-lived alpha-emitting daughters, increases the alpha activity and poses handling hazards of the irradiated material. Further, in cyclic irradiation of thorium (i.e. irradiation-cooling-processing for U-233 removal-irradiation) build-up of thorium-228 in the thorium mass increases with the number of cycles. In the present paper is evaluated the build-up of the

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above in converter reactors using Indian thorium. Due to the presence of uranium in the Indian monazite ore, the composition of Indian thorium is different from that of natural thorium. The various modes of production of uranium-232 from Indian thorium are described and the activity build-up from these different modes under the neutron flux conditions obtained at the blanket position of CIR is calculated. Build-up of thorium-228 in the irradiated mass in cyclic irradiation is calculated for varying cycle parameters.

345. Mineral Content of Fresh Waters and Fresh Water Organisms.

R. VISWANATHAN, Y. M. BHATT, J. R. NAIDU, G. R. DOSHI and C. KANNAN UNNI, Trombay.

The dry ash from species of fresh water fish and prawns in Maharashtra and Gujarat States has been chemically analysed for content of copper, iron, calcium and potassium. Calculations of ratios of mineral contents of the biomaterial to the corresponding concentrations in the respective fresh waters indicate that among other things differences exist between fishes and prawns in regard to concentration factors for copper and calcium.

The significance of the study of concentration factors is stressed in the context of determination of maximum permissible concentrations of radioactive isotopes in the aquatic environment.

346. Estimation of radionuclides in trace amounts in water.

M. C. MEHTA, Trombay.

Certain synthetic inorganic compounds act like organic resins as cation exchangers. In this paper, cation exchange properties of ammonium-12 molybdo arsenate are described and its possible use is suggested in the estimation of certain elements present in trace amounts in water.

Efficiency of this compound has been tested by employing the radioactive tracers of cesium, strontium, cobalt, scandium and cerium; conditions are described for the maximum absorption and quick elution of cations from a column of the heteropoly compound.

Quantitative recoveries have been observed in case of cesium, strontium and cobalt. Exceptional behaviour in case of cesium is encountered; radio cesium exchanges permanently with this compound. It has been observed that trace amounts of cesium-137 can be beta counted with the compound without employing self absorption corrections. The method offers a quick separation of radio cesium from a mixture of radionuclides.

347. Partition Function Ratios and Equilibrium Constants for Oxygen-18 Exchange Reactions.

S. C. SAXENA, D. N. BHATNAGAR and S. RAMASWAMY, Bombay.

Partition function ratios and the equilibrium constants have been calculated for oxygen exchange between several molecules and ions. The latest available frequency assignment data are used, and the various possible exchange reactions for the production of Oxygen-18 are critically examined.

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348. Production of enriched N-15.

D. GUPTA, M. GANESAN, M. N. NAYAK, S. D. PAUL, Bombay.

N-15 has been produced in concentrations of 90% and above using the chemical exchange process between Nitric Oxide and 8N Nitric Acid with a simplified column assembly and with minimum amount of moving parts and instrumentation. The process flow sheet, instrumentation and some of the major problems encountered in obtaining the required enrichment has been discussed.

349. Study of radioactive disequilibrium of uranium in ores and minerals : Preliminary studies on the quantitative ion-exchange separation of the various daughter products of uranium.

P. P. PAREKH, Bombay.

The study of the mode and the degree of radioactive disequilibrium in uranium bearing ores and minerals can provide important clues to the geochemical history of such deposits.

The above information can be obtained by isolating the key-isotopes viz., U-238, Th-230, Ra-226 and Pb-210 of the U-238 series in radiochemically pure forms, and comparing their abundances with the equilibrium abundances of the corresponding isotopes present in a uranium ore known to be in perfect radioactive equilibrium. In the present paper, a scheme of anion-exchange separation of the key-isotopes in Cl^- and NO^-_3 media at different acid concentrations has been presented. Quantitative retentions and recoveries of the key-isotopes in the two media at different acid concentrations have been evaluated, using suitable representative tracers of the key-isotopes.

350. Isotope Exchange Reaction Between Iodide and Iodate Ions.

H. J. ARNIKAR and R. TRIPATHI, Varanasi.

It is shown that paper chromatography can be employed conveniently for studying the high temperature isotope exchange reaction between iodide and iodate ions. Results are reported for the reaction velocity and period of half-exchange for the reaction at 240°C for three different equilibrium concentrations of the reactants, studied by this method. Data show the existence of an initial induction period which is, probably, associated with the formation of iodine and free acid in trace, the iodide-iodate isotope exchange being considered non-occurrent in a neutral medium of the pure reactants.

351. Study on the probable existence of Potassium indium alum with radioactive nuclei.

B. C. PURKAYASTHA and HIMADRI BIJOY DAS, Calcutta.

Distribution studies with In^{114} as guest and potassium ferric alum as host at 5°C show that homogeneous partition factor (D) comes out constant. Indium tracer is therefore taken up by the host lattice through mixed crystal formation. In consideration of the analogy of ferric iron to indium in such system conclusion can be derived that thus far unknown potassium indium alum does also exist. The value of the partition factor (0·4) indicates that the alum in question is much more soluble than potassium ferric alum. Study in known systems like Ga^{67} as

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guest and ammonium ferric and potassium chrome alums as hosts and In^{114} as tracer and ammonium ferric alum as carrier (where corresponding alums of the guest elements are known) gives further support to our finding that unknown potassium indium alum does exist.

352. On a search on the existence of scandium alum with Sc-46.

B. C. PURKAYASTHA and K. N. DUTTA, Calcutta

Distribution study with Sc^{46} as tracer and ammonium ferric alum $NH_2Fe(SO_4)_2$, $12H_2O$ as a host lattice at 4°C shows that homogeneous distribution factor (D) comes out constant over a wide range of concentration of the tracer ion. Uptake of scandium by ferric alum therefore takes place through mixed crystal formation. In consideration of the analogy of scandium with iron it can be claimed that the uptake of scandium through mixed crystal formation is a positive evidence on the existence of thus far unknown scandium alum. Radioactive indicator thus finds an useful application to expand our knowledge even in search of such an interesting compound where classical methods of attempt are not feasible.

It is of interest to point out that Mendeleef predicted that scandium (ekaboron) will not form any alum. Evidence that we have gathered gives, however, a positive hope that scandium will also behave like other neighbouring tervalent elements which are wellknown to form alum and under favourable circumstances scandium alum may also be isolated. Details as regards our study on transition temperature and isolation of the alum in question are under progress.

353. On the indirect application of radioactive nuclei in analytical chemistry. Part V.

B. C. PURKAYASTHA and V. R. PAI VERNEKER, Calcutta-9.

Sc^{46} has been used to examine the validity of the methods for estimating scandium. It has been found that the method based on the precipitation of scandium as hydroxide and its subsequent ignition is a dependable one. It has also been observed that scandium even in sulphuric acid medium undergoes complete hydrolysis when boiled with iodate and iodide mixture. The iodine liberated in the process can be collected and estimated either by hypo titration or by radiometric method with I^{131}. In case of radiometric procedure scandium up to 0·09 mg can be estimated with fair degree of accuracy. Using labelled pyrophosphate ($Na_4P_2O_7$) scandium up to 0·9 mg. has been estimated by radiometric method within statistical fluctuation. Rare-earths do not interfere in the estimation of scandium as pyrophosphate.

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SECTION OF GEOLOGY AND GEOGRAPHY

President : Dr. K. P. Rode, M.Sc., Ph.D. (Zurich), F.A.Sc., F.G.M.S.

Abstracts.

GEOLOGY

(i) Mineralogy

1. New occurrences of Beryl from Palamau district, Bihar.

G. K. MODAK, Calcutta.

Occurrences of Beryl have been recorded for the first time by the author from (1) Dhangaon and (2) East of Banai in the district of Palamau, Bihar.

At Dhangaon (24° 01′ : 84° 14′ 30″) pale greenish coloured beryl occurs scattered in a nearly vertical beryl bearing white quartzvein. The Beryl bearing white quartz vein trends N (65-70) East—South (65-70) west and occurs beneath the surface. The country rock is Archaean granite gneiss traversed by the beryl bearing quartz vein.

Another beryl bearing mica-pegmatite vein intrusive into the granite gneiss, has been located on the hill about one and a half miles East of Banai. The beryl bearing mica-pegmatite vein strikes N 75 E—S 75 W i.e. due E-W and is traceable for a distance of about 450 feet along the strike, and the width of the vein varies from 20 feet to 100 feet. Beryl occurs here interlocked in the quartz core of the zoned pegmatite intrusive into the Archaean granite gneiss.

The chemical analyses of the two samples from each of the locality show 12·52 and 11·18 per cent of BeO respectively.

In view of the high percentage of BeO detailed prospecting would be desirable.

2. Perthites in Nepheline Syenites of Koraput, Orissa.

MIHIR KUMAR BOSE, Calcutta.

Perthites in nepheline syenites of Koraput are composite types. The striking feature of the intergrowths is the regularity in orientation of the albite units. The different types have been studied in oriented thin sections. The albite strings and films are arranged on an ortho-hemidome and the coarser bands are developed close to (100) of the host. Braid perthites are composed of two sets of albite spindles oriented along the prism directions. Albite frequently forms patches near the margin of the perthite grains from its tendency to move out of the host. Nature of the grain contacts and textural features suggest the patch perthites to be genetically connected with discrete albite in the rocks. Grain contact counts reveal the development of albite rims to be overwhelmingly associated with nepheline-perthite contacts. Such rims in optical continuity with intergrown albite in the perthite are likely due to interchange of soda and potash of adjoining minerals. Guttate perthites are relatively rare. Antiperthites are developed due to extensive replacement along (100) and (001) of the host by albite.

Composition of perthite, determined by point counting, camera lucida drawings and chemical analysis, is found to range about $Or_{54}Ab_{46}$. Relative abundance of various types of perthites across the body has been studied. Intergrowths are

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primarily due to exsolution, supplemented by later corrosion and replacement. The perthites, their composition and evolution suggest a magmatic history of the rocks containing them.

3. Clay mineralogy of the Rajahmundry Sandstones and Chintalapudi Sandstones from Nuzvid area. Andhra Pradesh.

B. B. G. SARMA, Waltair.

Clay mineral extracts from shales and shaly sandstones of Chintalapudi stage and of Rajahmundry sandstone series from Nuzvid area (eastern half of G.T.S. Sheet No. 65 (D/13) were studied by X-ray methods. A CuKa target was used with a camera of radius 57·2 mm. The time of exposure was uniform in the case of all the samples. Samples of Chintalapudi stage gave characteristic lines only for kaolinite. Samples of Rajahmundry series gave lines for kaolinite, illite and chlorite with kaolinite making up the bulk.

Clay minerals have a very wide range in chemical composition and are consequently very sensitive to changes in physico-chemical conditions at the time of formation. Therefore, theoretically in a palaeoenvironmental study, clay minerals will be useful. There is no general agreement on the utility of clay minerals as indicators of absolute environments. But most of the workers feel that, when several environments are present, it is possible to assign them a sequential order ranging from more continental to more marine, on the basis of their clay mineralogy.

The Chintalapudi sandstones on the basis of the clay minerals seem to be purely continental; coupled with the other data available about these rocks, it is concluded that they are fresh-water lake deposits. On the other hand, the Rajahmundry sandstones show an admixture of clay minerals. Since it is dominated by kaolinite, the environment also may be dominantly continental, but the admixture of illite and chlorite would indicate marine influence. They may be estuarine deposits.

4. Mineralogical study of Raghavapuram Shales from Duddukur area, Andhra Pradesh.

B. B. G. SARMA and V. RAMESAM, Waltair.

Variegated shales belonging to the Raghavapuram stage of the Gondwana system of rocks outcrop in the Duddukur area near the villages of Yelachintalagudem (17° 6′; 81° 33′ 30″) and Peddapuram (17° 6′; 81° 34′ 15″) as a band roughly running E-W and dipping gently to S.E.

The heavy mineral assemblage from the shales is characterised by a predominance of tourmaline. The immediately older Gollapalli sandstones have a much lower content of tourmaline and good amounts of kyanite and sillimanite. An antipathic relationship seems to be indicated. It is suggested that the tourmaline present in the shales is authigenic in origin and has formed at the expense of kyanite and sillimanite, boron and silica having been derived from sea-water and alumina from kyanite and sillimanite. A similar explanation was offered earlier (Keith and Degens, 1959).

Thermal analysis and Dye techniques revealed the presence of illite and chlorite as the clay minerals present. Illite and chlorite indicate a marine environment (Weaver, 1960), considered in conjunction with typical marine fossils in Raghavapuram shales from elsewhere (Krishnan, 1960) the clay mineralogy can thus be used as a valuable criterion in determining the depositional environment.

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5. Anti-symmetrical nature of fixations of components and significance in Geology.

AMITAVA DUTT, Giridih.

Let us consider a harmonic oscillation model of an isolated, normal liquid system having many components cooling from high temperature. Components having different mass, volume and energy are generally in different energy states and may broadly show different concentration zones. The components of neighbouring zones colliding with each other at high velocities react with suitable activation energy at favourable conditions. If only a particular group of components is considered, then with their cooling their absolute activity and entropy as a function of temperature, volume and composition will decrease and compotents will attend fixation at minimum potential conditions.

If the partition function is taken as -E(energy)/kT then the variation in absolute activities from initial to fixation states is 2 sinh (-E/kT) showing exponential graphs. Similarly if partition function is taken as (1-exponential of -hv(frequency)/kT), variations in the free energy of components from liquid at high temperature to crystalline state when plotted shows anti-symmetrical curve. On both cases fixation function is antisymmetrical and therefore unique. In other words, not more than one characteristic component may be fixed at a time and given condition, resulting in only unitary appearance of a characteristic mineral. Successive ensembles of minerals at equillibrium conditions show the difference of one only.

(ii) Petrology

6. On the Rhyolites of Pavagad Hill.

S. C. CHATTERJEE, Bhopal.

Rhyolites are found forming the topmost turret of the main Pavagad Hill and are also found on its eastern slope and ridge and again on the top of the isolated northern hill. It forms also an outlier to the south-east. It is believed by some that all the rhyolites in the different parts of the hill are derived from the topmost flows, while there is an alternate view that they are *in situ*. In this paper a detailed petrographic description of the rhyolites is given and it is shown that at the top there are tuff flows in addition to flows of viscous lava. A comparative study based on the mode of occurrence in the field, petrographic characters and chemical composition is presented in the paper and it is shown that while many of the boulders along the pilgrim route have rolled down from the top, the rhyolites on the eastern flank and on the northern ridge are *in situ*.

The source of the rhyolite magma is briefly discussed.

7. Some aspects of the Petrochemistry of the Deccan traps.

S. K. SAXENA, Bhopal.

A small progressive change is noted in the chemical composition of the Deccan Traps from the lower to the Upper traps when the oxide percentages are plotted against the differentiation index values. The differentiation index values as devised by Thornton and Tuttle when calculated for the normal basalts fall within the values of 25 and 45. The Lower Traps show values around 29 and the Upper Traps show values around 39. There is a regional distribution of these values and towards the west more and more differentiated (in a limited sense) flows occur.

Trend of differentiation as noted within the normal basalt is not towards the

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production of felsic rocks. There are no intermediate rocks between the felsites and the basalts, therefore the differentiation curves (differentiation-index plotted against oxide percentages) should not be prolonged to the felsic end as has been done by Sukheswala and Poldervaart.

Till more work is done to prove the relation of the normaltraps to the ultrabasic and acid rocks noted in western India, these should be treated as separate magma entities. The type of progressive change noted can be due to limited unmixing in a gravitative molecular differentiation.

It can be argued from the differentiation index values that the thick flows near Bombay may contain the whole sequence from the Lower to the Upper Traps and as such this area might have been the foci of fissure eruptions from where spread the lava flows.

The need of more planned geochemical work is felt and expounded.

8. Study of the selective alteration of the Ultrabasics of Bhimtangar (Sukinda) area, Cuttack district.

M. MOHANT, Cuttack.

The area studied for the ultrabasics and the chromite ores occupy about 30 sq. miles and is bounded by 21°·0′ n—21°·4′ N and 85°·45′ E—85°·52′ E. The altered and unaltered ultrabasic rocks are found in form of steeply inclined isolated lenses running parallel to each other in a NE-SW direction which happens to be the axis of the iso-clinal anticline fold of the quartzite into which they have intruded concordantly. The NE-SW trend conforms to the Eastern Ghats strike and these rocks are connected with the Eastern Ghat orogeny. This type of ultrabasic association is called the Alpine type by Benson. Two of the three varieties of primary ultrabasics have been recognised in the field on the basis of their selective alteration. Those two have been doubtfully taken by the author as Iron-rich dunite (?) which has been lateritised and silicified and the other as Magnesium-rich dunite (?) altered to talc-serpentine schist. The third variety is the unaltered enstatite peridotite rock which is very fresh. The study of the alteration of this suits of ultrabasics is very interesting. The chemical nature of the primary ultrabasics has governed the alteration. Both the Iron-rich and Magnesium-rich ultrabasics have undergone hydrothermal alteration and solution has been derived from the ultrabasic magma. In the former case Iron oxide (altered to limonite), secondary quartz and very little specks of antigorite have been formed. The rock has been lateritised under tropical conditions. In the latter case greater amount of antigorite and small amount of talc have been formed. Talc occurs at the expense of antigorite suggesting that serpentinisation was older than steatisation. A late-magmatic (residual-liquid injection type) of origin has been assigned to the chromite ores occurring in the shear zones of the talc-serpentine schist and lateritized-silicified rock.

9. Occurrence of calc-silicate Rocks around Dhanwar-Jamua area, Hazaribagh district, Bihar.

S. N. P. SRIVASTAVA, Calcutta.

Calc-silicate rocks, recorded for the first time in the area lying between latitudes 24°12′—24°30′ and longitudes 85°45′—86°15′ in the district of Hazaribagh, Bihar, form concordant narrow elongated and discontinuous patches and small mounds and elongated ridges in granite gneisses and schists. They are mostly granulitic, in places gneissic schistose in structures.

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The calc-silicate rocks include the following types :

(1) Calc-granulites represented by diopside-garnet-epidote allanite-, diopside-garnet-hornblende-allanite-epidote-, garnet-epidote-allanite-, enstatite-diopside-clinoestatite-garnet-, zoisite-allanite-hornblende-augite-, diopside-hornblende-actinolite-, hornblende-epidote-, hornblende-diopside-epidote-, zoisite-clinozoisite-spidote-allanite-, epidote-garnet-actinolite-, hornblende-epidote-allanite granulites.

(2) Calc-schists the varieties of which are hornblende-diopside- tremolite-actinolite schists.

Felspars (plagioclase mostly) are among the essential minerals. Sphene, magnetite, ilmenite altering to leucoxene and quartz are the common accessories. Under the microscope epidote is usually green with grains of allanite as occasional inclusions. These allanites often produce radial cracks in epidote perhaps due to radioactivity.

10. Superposed metamorphisms in south-east Chotanagpur and adjacent areas.

P. S. CHAKRAVARTY, Jadavpur.

Some evidences which indicate polymetamorphism was prevalent in different parts of South-east Chotanagpur and adjacent areas are recorded. Sources of the evidences are (1) Age-determination data, (2) Structural analyses, (3) Petrographic studies, (4) Distribution of zones of metamorphism. As early as 1942, Dunn and Dey invoked presence of polymetamorphic effects in the Pre-Cambrian terrain of Singhbhum. According to them Dalma volcanics were deposited on the denuded surface of metamorphosed Iron Ore Series of rocks. Out of the Dalma volcanics are themselves converted to epidiorites. So a peak of metamorphism of the Iron Ore Series rocks reaching upto amphibolite facies was followed by another peak of metamorphism reaching at least greenschist facies with considerable time gap. Later workers seem not to have attached sufficient importance to this very important aspect of Singhbhum Geology. The author adds to the conclusion of Dunn and Dey that superposed metamorphism reached upto amphibolite facies in the precambrian tract bounded by the Great boundary fault and Dalma overthrust. The Kuilapal granite is a mantled gneiss dome bearing imprint of more than one orogeny. The basic bodies are arranged in the structural planes of the old granite. Again the granite has been paligenetically eruptive into the basic bodies and has sent veins and epophyses into them and older gneiss. Even this palingenetic granite and its mantle are traversed by a number of crush surfaces in which occurs 'pseudotachylite' or 'flinty crush rock' believed to be product of remelting of the rocks due to heat generated by mechanical rushing. The outcrops of pegmatoid Chhendapathar and Chapri granites bearing no imprint of penetrative structures are aligned along a hidden overthrust zone. Tungsten-copper mineralisation is definitely related to this overthrust zone and also to these late to post tectonic granites. Along the overthrust zone and contacts of the granites large crystal aggregates of andalusite and sillimanite are available definitely indicating thermal metamorphism superposed on regionally metamorphosed rocks.

In Singhbhum and adjacent areas, metamorphic cycles would be more clearly understood as tectonic history of the terrain is more clearly brought out by structural and petrographic analyses and age-delemination data. At present we can decipher at least two tectonic cycles and should expect larger number of superposed metamorphisms.

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11. The geology and petrology of the Khasi Greenstones near Shillong, K & J Hills, Assam.

J. M. CHOUDHURY, Gauhati.

The Khasi Greenstones form a distinct rock type in the Archaean Complex of the Shillong Plateau. They outcrop as narrow dykes or irregular bosses cutting across the Shillong quartzites. In general Khasi Greenstones are fine to medium grained rocks with dark green to black amphiboles and grey feldspathic interstitial matter. The hornblendes are bluish green occurring as big poikiloblastic plates enclosing other crystals. The feldspars are andesinic and are highly altered. Epidote, zoisite, ilmenite, sphene and magnetite etc. are the accessories. Sometimes palimpsest structures indicating former presence of titaniferous pyroxenes are shown by the ilmenite and magnetite grains. In general, the texture is granoblastic. Structurally and texturally, the Greenstones are found to be quite different from the amphibolites and the hornblende-schists which occur in other parts of the Archaean complex. They still retain much of the textures of the original plutonic rock from which they are derived. It is concluded that the Greenstones were derived from basic igneous rocks of gabbroic composition and had undergone regional metamorphism along with the quartzites of the Shillong Series prior to the intrusion of the Mylliem granite. The mineralogy indicates that the Greenstones belong to the Aphibolite facies. The field relations and structural evidences show that the rocks belong to Middle Dharwar age.

12. A note on the occurrence of amphibolite around Gurio in the northern vicinity of Tilaiya Reservoir, Bihar.

R. C. MISHRA, Patna.

The paper gives an account of the mineralogy and occurrence of amphibolite in the northern vicinity of Tilaiya reservoid around Gurio. It is a coarse grained greenish looking melanocratic rock composed mostly of amphiboles which possess radiating structure even in hand specimen. The study of the thin section reveals that it is a plagioclase amphibolite rock composed mostly of pale green actinolite and plagioclase plus a little epidote and magnetite and biotite. The paucity of mica has caused absence of visible schistosity in hand specimen. The above mineralogical character of the rock is indicative of igneous parentage. The rock as a whole contains the typical assemblage of minerals so as to be placed in the amphibolite facies.

13. A study of the sedimentation phenomena in the south-west coast of India.

K. M. V. JAYARAM and R. KRISHNASWAMY, New Delhi.

The western coast of Kerala was studied in some detail with regard to sea currents and winds, and with regard to mineralization at various points along the beach and in the sea bed. The data collected indicate the following trends.

1. The rivers flowing west from the western ghats (which form the watershed of the peninsula) do not carry the sediments to the sea due to the formation of the bars at the outlets as a result of sea currents and monsoon winds.

2. 44% of the winds coming from North and North-West result in a erosion of the South-Western parts of the beach to an extent of 15′ per annum. To the north the wind rose changes.

3. A study of the sediments of the sea and the beach prove that the enrichment of the heavy minerals due to sea action is 7 to 8. The size analysis of the

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sediments on the beach and the sea indicates no noticeable variation. This, contrary to the present belief, together with the fact that the ilmenites derived from the sea show the same degree of rounding off of the edges and leucoxination, indicates that there is very little, if at all, of fresh addition to the sea bed from the original sources. There is only a constant making and remaking of the coast line.

4. A study of the wind roses, sea currents and refraction diagrams prove the existence of a northerly littoral drift. The sedimentation data correlated on a Stereogram prove a mean depositional trend of N 54° E and a littoral drift at N 36°W—along the coast line. The accretion of the bars and the general widening of the sea bottom contours substantiate this view.

14. Sedimentaries and the associated formations in parts of east Godavari district. (Peddapuram-Jaggampeta area).

R. S. SHENOI and M. POORNACHANDRA RAO, Waltair.

The area lying between Lat : 17° 0′ 0″N; 17°12′ 30″N; and Long : 82°0′ 0″E., 82°12′ 30″E; included in the G.T.S. Sheet No. 65 K/4, has been geologically mapped on 1″ to a mile scale. The formations, striking uniformly N.E.-S.W. and dipping at varying angles, are the Khondalites, the Upper Jurassic Gondwanas, the Deccan traps, the Rajahmundries and the recent Eluru River Alluvium (no strike or dip). W. King (1883) expressed a doubt about the Gondwanas (referred as 'Doubtfuls' here) whether they are Gollapillies, Tirupaties or Rajahmundries. The following studies were made to correlate this Doubtful patch and to investigate the environments of sedimentaries.

Size studies show that (1) the Doubtfuls as well as the Rajahmundries are well sorted ('So' values 1·702 and 1·511), but the latter are better sorted; (2) both sediments are coarse grained, the Rajahmundries being comparatively finer; and (3) both are composed of well sorted mixtures of particles of diverse source rocks. The presence of 93% of Rajahmundry and 73% of Doubtful grains having sphericity values more than 0·65, indicates the higher spherical nature of the former. The lower average elongation quotient value, 1·615, of the Rajahmundries compared to 1·961 for the Doubtfuls, imply the more equi-dimensional nature of the metamorphic quartz in the former. The above two factors testify that both the sedimentaries have the Archean metamorphic suite of rocks as their common provenance. In the case of younger Rajahmundries, there is addition of material from the Doubtful sediments and the Deccan traps. These facts are further borne out by (1) the presence of undulatory detrital quartz grains (metamorphic provenance); (2) the similar heavy mineral assemblages in both the sedimentaries; and (3) the pink to red pigmentation of Rajahmundries (28·8% of iron) compared to the felspathic brown colour of the Doubtfuls (5·2% of iron), contributed mostly by traps in the former case. The pitted garnets in the Doubtfuls and an enhancement in the heavies of the Rajahmundries warrant the efficacy of the intrastratal solutions and diversification of the provenance respectively.

From a comparison of the general characteristics and consideration of the environmental factors, such as the presence of kaolinised felspar in the doubtfuls; the highly oxidising nature of Rajahmundry environment as evidenced by the red beds; and other maturity factors listed earlier, it is surmised that the former were deposited in freshwater, and the latter in transitional environment. It is concluded that the Doubtfuls and the Rajahmundries of the area are distinct from one another, and upper Gondwana age can be assigned to the former.

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15. Study of variegated clays occurring in the Gondwana succession in Kanhan Valley of Chhindwara distrist (M.P.).

R. T. SHUKLA, Udaipur.

During the course of investigations in Kanhan Valley of Chhindwara District, M.P., author came across some interesting observations regarding the occurrence of variegated clays. These are found ubiquitously in all the horizons of Lower Gondwana formations comprising Talchirs, Barakars, and Moturs overlain by trap. These clays are of white, red, green brown and chocolate colour and are lined up with limestone nodules. They frequently contain kernels of altered trap. They are devoid of fossils or any organic remains. The clays are lenticular and are of variable thickness. They are intercalated with Gondwana sandstones and occupy the bedding planes of the former. Their field characters backed up by laboratory investigations, reveal that they have probable genetic relationship with trappean material, and have no climatic significance as asserted by previous workers in the area. References from literature from India and abroad have been given in support of this working hypothesis.

16. Characteristics of tropical weathering of the rocks of iron ore stage, Patmunda-Koira region, Bonai subdivision, Orissa.

NIRENDRA BHAUMIK, Jadavpur.

This is a tropical region with high topography, 2,000 ft. on an average with dry hot, moist hot, humid, and cooler climate inculcating in the weathering solution a very specific acidity, alkalinity and redox potential characteristic of that particular season and hence produce differential weathering.

Geologically, the area is an Archaean terrain comprising the Iron Ore Stage of the I.O. Series—the shales (argillaceous, arenaceous and tuffaceous) and banded iron formation (B.H.J., B.M.Q., Quartzites and cherts).

It has been noticed that the chemical composition of the rock largely determine the weathering characteristics of iron and silicon and the composition of weathering solution. Rock texture as porosity, permeability also exerts important influence.

Large scale silicification in arenaceous rocks, including that of shale, pure iron concretions of fine crystalline as well as amorphous goethite in argillaceous shales, formation of Fe, Ca carbonate around Fe nuclei in iron formations are important features. Rocks between argillaceous to sandy ferruginous shales and quartzites are invaded by fine reticulate venation of seams of membranous goethite, sandwitched, inbetween are cryptocrystalline fine powdered silica. The separation of Fe and Si from a composite solution is suggested to be due to dialysis.

Apart from bulbuous swellings and mamillary features Mn bearing tuffaceous shales exhibit a centrifugal tendency of Fe and Mn contained within.

(iii) Economic Geology

17. Ore minerals in ultra basic rocks.

J. S. R. KRISHNA RAO, Waltair.

More than about 250 Ultrabasic rocks from various parts of the world were examined Ore-microscopically for their common Ore-minerals. While most of these rocks are barren of any ore-minerals, some have economically workable chromite,

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A few of these contain sulphides of nickel like pentalandite and some Pyrrhotite of no economic value. During the process of metamorphism and alteration secondary minerals like awaruite, pyrite, magnetite, gntheite, limonite appear.

This study leads to the following facts : (1) Ultrabasic-rocks which contain ferromagnesian minerals are essentially devoid of any striking mineralization. (2) Chromite is the only workable ore mineral. (3) Rarely as in Sudbary, nickle-sulphides segregate. (4) During the process of serpentinzation most of the iron released appears in the form of late magnetite. (5) If the silicates and sulphides of the Ultrabasics are nickel bearing under appropriate environmental conditions (Oxidation or reduction) they give rise to nickel iron (Ni_2Fe).

18. Paragenesis of awaruite.

J. S. R. KRISHNA RAO, Waltair.

The author has studied the paragenesis of awaruite during his stay in 'Mineralogisch und Petrographisches' Institute of Heidelberg, West Germany under the inspiring guidance of Prof. Paul Ramdohr and Prof. Arno Schüller. The study is based mainly on ore-microscopic methods substantiated by synthesis and X-ray analysis of the mineral awaruite. It suggests :—

(1) that awaruite is not orthomagmatic as it was suggested in many classical text books on ore-mineralogy and mineral deposits.

(2) that awaruite is not genetically related even to the late magmatic processes.

(3) that awaruite is essentially a secondary mineral formed by the reduction of nickel sulphides. The possibility of its origin due to nickel bearing silicates is not ruled out. The study also brings out that most of the *recent ophioliths* are the home of awruite. The study further leads to the discovery of new localities. The new localities are :—

Jackson City, N. Carolina, Br. Columbia.
Elba, Virginia, U.S.A.
Philadelphia, Pennsylvania, U.S.A.
Turin, Italy, Terradifonohetts, Bolognia, Italy.
Blörke, Geraquamotal, Italy.
Wedessos, Austria.
Bogsan, on Berzava river, Banat, Hungary.

19. Hypogene dispersion of copper in the vicinity of lodes in Rajdah area, Singhbhum district, Bihar and its relation to the secondary dispersion.

S. K. BOSE and J. G. K. MURTY, Calcutta.

Experimental sampling of the rocks near the old workings and the suspected mineralised zones was done in Rajdah area to test the hypogene dispersion of copper in the vicinity of lodes and to find out the possibility of locating blind ore bodies underground. About 2000 feet strike length of the Rajdah lode was prospected by sampling of the rock chips and collection of soil samples (9 and 15 inches depth) across the strike of the rock formations/suspected mineralised zones. The dispersion pattern in soil and rocks is very interesting, the details of which are given in a table form.

The rock types are mainly quartz chlorite schist and quartz sericite schist with disseminated magnetite and traversed by quartz veinlets. The primary halos

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vary in range from 50 to 2000 P.P.M. of copper whereas the soil samples are within 75 to 500 P.P.M.

In one of the line rock values show 250 P.P.M. of copper against 500 P.P.M. of copper in soils at a distance of 200 feet from the lode towards the hanging wall side. It is also observed that up to 260 feet towards the footwall of the first line of working, copper dispersion in rocks has taken place, though the values have diminished considerably. Here, the values in rocks and soils are almost identical. In one of the suspected mineralised zones, the copper values in the rock samples are much more pronounced than those of soil samples and in some cases almost double. In another line the rock values show two abnormal 'Highs' of 1500 and 2000 P.P.M. of copper compared to 75 and 175 P.P.M. in soils respectively. Dispersion halos in the rocks appear to be 'leakage halos'.

Deeper soil sampling and closer spacing of the rock sampling will be helpful to confirm the values already obtained which suggest the existence of a rich zone, may be of limited extent.

20. A note on the copper mineralization of Kolihan section of the Khetri copper belt, Rajasthan.

O. P. VARMA and K. C. PATNI, Dhanbad.

The Khetri copper belt comprises a mineralized zone of about 16 miles in length lying between the towns of Singhana (28° 6′, 75° 54′) and Babai (27° 53′, 75° 49′) in the Jhunjhunu district of Rajasthan. This paper incorporates the results of investigations of Kolihan copper deposits.

The area around Kolihan ridge is composed largely of metamorphosed sediments of Alwar-Ajabgarh series of the Delhi System, repeatedly folded into isoclinal anticlines and synclines, and which consist of highly jointed quartzites, chlorite-actinolite-tremolite schists, mica-schists and phyllites (with or without andalusite), generally with a N25°E to N45°E trend and northwesterly dip between 30° to 35°. Sills of amphibolite and a large number of scattered sills and dykes of epidiorite occur in the Alwar sediments of the area. The Erinpura granite intrudes the Delhi rocks, while quartz veins, cutting all the earlier formations, are abundantly scattered throughout the area in a haphazard manner. Many of them with metallic mineral matter are well-developed near the mineralised zones. All the igneous rocks of the locality are post-Delhi in age.

The core of the mineralized zone, which extends over a length of about ¾ mile, with a maximum width of 50 ft. comprises a system of fracture-filled linked ore-veins, flanked by disseminated sulphides in the brecciated wallrock. Faults seem to have acted as feeder channels, and shear fractures and foliation planes as ore receptacles. The accompanying rock alteration by chloritization, sericitization and to a less degree by biotitization is intense in the vicinity of copper orebodies. Marked feature of wallrock is the development of garnet, andalusite and chiastolite crystals and of feathery amphibole in the Chandmari group of old workings.

The primary sulphide ore consists of chalcopyrite, pyrrhotite, pyrite, marcasite, arsenopyrite together with malachite and azurite as oxidation products of primary copper minerals. The deposits are characterized by abundance of magnetite. Introduced gangue minerals are quartz, chlorite, sericite, calcite, tremolite, garnet etc.

The deposits represent high-temperature hydrothermal replacements. The mineralizing solutions were probably derived from the pre-mineral intrusion of Erinpura granite.

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21. Some new occurrences of Galena from Palamau district, Bihar.

G. K. MODAK, Calcutta.

The author records for the first time occurrences of Galena near Singhitali and Hendea (Baitri) in the area around Bhaunathpur, Palamau district, Bihar. The area lies in topo sheets 63P/11 and 63P/7.

At Singhitali, Galena is found to occur as thin stringers, patches and also as specks in association with quartz and copper ores (Chalcopyrites and Malachite) in compact, grey, jointed, impure fine grained quartzites and silicified rocks probably belonging to the Lower Vindhyan (?).

About one mile SE of Hendea (Baitri) Galena occurs in a east-west striking mineralised zone (700′×60′, maximum width being 80′) composed of yellow and brown ferruginous limonitic gossan showing box structure, consisting of a number of more or less parallel and also a few intersecting thin iron-stained quartz veins, in association with a limestone-sandstone sequence. Some of these quartz veins may also be barren. The length of the quartz vein varies from four inches to 10 feet, and the width from about half inch to six inches. The principal ore mineral is galena associated with specks and patches of copper ores (chalcopyrite altered to malachite) and the gangue minerals are quartz (both massive and crystalline) and limonite.

In polished sections galena, covellite and quartz have been identified.

A few samples of galena were analysed for its Pb (Lead) contents. Values ranged between 9 and 75%

The galena deposit of Hendea (Baitri) appears to be promising and merits further attention. The areas around Bhaunathpur requires geophysical and geochemical prospecting for lead mineralisation.

22. The Degana Wolframite deposit, Nagaur district, Rajasthan.

Z. M. MOGRI and O. P. VERMA, Dhanbad.

A study was made of Wolframite-bearing hydrothermal quartz veins in a locality near Rewat Village. Preliminary investigations reveal the following results :—

The formations include pre-Cambrian schists of the Aravalli System, intruded by granitic rocks, and recent sand and gravel beds. The granite has produced pronounced effects of thermal metamorphism on schists. Three prevalent directions of joint systems in the granite are noted : (i) N60°W to N70°W, (ii) another NNW, and (iii) less prominent roughly E-W.

Innumerable veins and stringers of quartz traverse the rock formations. Quartz bodies are of two types (i) barren, (ii) minearlized. They occur in granite, in schists or at granite-schist contacts, ranging in thickness from a few inches to about 2 ft. with NW-SE to NNE-SSW trend. Most of them are vertical or dip towards west, locally being characterised by banded structure formed by alternating layers of mica and quartz. Wolframite is devoid of such banding, nor does it show preference to any particular type of bands. On the other hand it occurs in small veinlets cutting across quartz and muscovite layers. There is no marked difference in the mineralogical composition of the veins except that the ones in schist and at or near granite-schist contacts contain greater amount of topaz.

The ore bodies are (a) mineralized granite, (b) veins and irregular aggregates of quartz, and (c) gravel bed containing lumps and fines of wolframite with boulders and pebbles of granite cemented with sand and clayey matrix. Greater concentration of the ore is found in veins rich in mica traversing dark granite.

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Locally, wolframite is considerably oxidised into ferritungstite and tungstite which, in their pale brown to dark brown colour, fill the intergranular spaces. Other ore minerals such as chalcopyrite, pyrite and bornite, which were not visible on the surface, were observed in the cores from drill hole No. 1. Since the drill cores containing those sulphides were not available to the authors, the paragenesis of ore minerals could not be made out. However, the probable paragenetic sequence of other minerals in the veins appears to be muscovite, quartz, wolframite, quartz and orthoclase, fluorite, topaz and the late quartz.

The deposits display a close connection with the granite intrusive from which emanated the wave of hydrothermal solutions that filled the cracks and fractures in the granite as well as in the country rocks.

23. Vanadium in the Dhalbhumgarh sub-division, Singhbhum district, Bihar.

S. N. P. SRIVASTAVA, Calcutta.

The paper deals with the economics of vanadium in titanium bearing vanadiferous magnetite ore occurring between the parallels 22° 21′-23′N. and 86° 30′-35′E., and 22° 23′-33′N. and 86° 15′-21′E. in the Dhalbhumgarh sub-division, Singhbhum district, Bihar. The magnetite ores occur associated with either altered basic (gabbro and dolerites) or ultrabasic (peridotites, pyroxenites and eustatites) rocks which appear originally to intrude into the Iron-ore Series represented either by Phyllites, schists or quartzites in thirteen localities. In most of the areas scree, even weighing up to 16-20 pounds, are noticed along the slopes of the hills. Apart from these, they occur in form of either veins, lenses or segregated materials. The fresh ore is always back, shining with metallic lustre and highly magnetic, where much altered to hematite or limonite it shows dull lustre and becomes feebly magnetic. The minerals found within magnetite are ilmenite, hematite, replacing magnetite, martite, and maghemite formed due to oxidation.

Considering only 0·75 per cent and above of vanadium to be the economically workable limit for vanadiferous magnetite ore, the deposits at Dublabera, Lango and Dhengam appear to be important. At the other places the vanadium content in the ores varies between traces to 0·64 per cent. The average vanadium content at Dublabera area is 1·10, at Lango 1·12 and at Dhengam 0·56 per cent. The total quantity of vanadium available from the ores in these areas, respectively, are of the order of 7,546, 2,837 and 1,000 tons up to a depth of 100 feet (or 30 metres). The estimation of reserves in these localities is also based on the observation of some old and new workings.

All these three areas form one unit as they lie within a distance of about one mile (or 1·6 km.) from each of them. They are connected by *Kutcha* motorable road to Haludpukur railway station lying about 20 miles away and gross quantity of vanadium available in the area is about 11,400 tons.

These ores also contain 10·0 to 16·25 per cent of TiO_2 which has also to be separated for the extraction of vanadium. A suitable methods of beneficiation will however, have to be evolved for facilitating the extraction of vanadium from such ores.

24. A study of Magnesite and its origin in Almora district, U.P.

V. S. DUBEY and P. C. DIXIT, Varanasi.

The paper gives the result of the study of the Magnesite deposits in Almora District, U.P. These deposits are invariably associated with Dolomitic Limestone supposed to belong to Krol Series where it has been intruded by the basic sills

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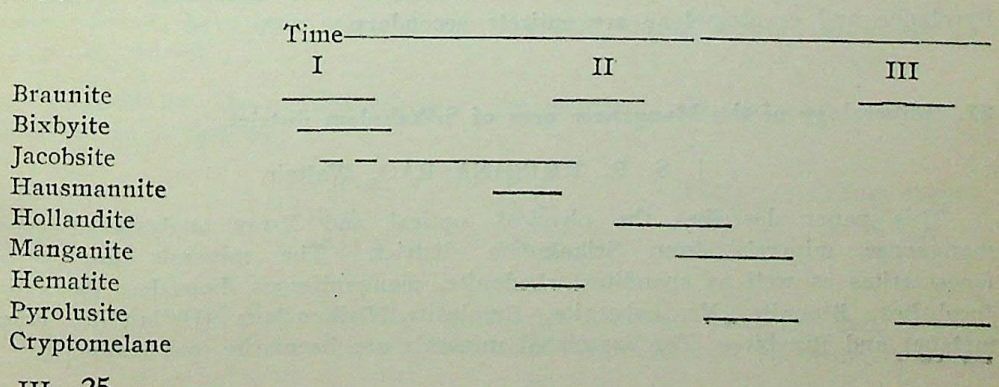
and dykes and covered by the Tal Quartzites or Slates. In majority of cases the Magnesite is found intimately associated with the deposits of Talc and at times interbedded with it. The deposits extend up to several hundred feet from the basic sills and dykes both in vertical and horizontal directions. The occurrence of Talc is exactly similar to that in Rajasthan, except that the Magnesite has developed here on a much larger scale than in Rajasthan. The minerals Magnesite and Talc seem to have been formed by the action of carbonated waters together with siliceous solutions emanating from the magma supplying the material for basic sills and dykes. The carbonated waters have dissolved away Calcium Carbonate leaving Magnesium Carbonate while action of siliceous solutions on Magnesium Carbonate has given rise to Talc and has turned the basic dykes and sills into Chlorite-Schist at the margin as is seen in Rajasthan also. The presence of these deposits near the upper horizon of the Dolomitic Limestone can be explained by the fact that the fluids emanating from the basic magma could not escape higher up due to the presence of impervious quartzites of Talc and Slates and spread laterally and downward replacing Dolomitic Limestone hydrothermally. At places transition of Dolomite into Magnesite and Talc can be seen clearly in the field and in some cases in the same specimen. Thus the field study completely rules out the direct sedimentary origin of these deposits.

Each deposit is not very big but it is possible that the total tonnage of Magnesite in the District may very well range in the order of several millions. Several deposits are capable of being exploited commercially and are connected by the road to the Railhead, average distance being hundred miles. At a suitable site in the District a hundred ton capacity Calcined-Magnesite-Plant can safely be installed. It is calculated that if calcined on the spot in an Oil-fired Rotatory Kiln, the calcined material may cost about Rs. 200/- per ton delivered in Bengal and Bihar at the site of Steel Industry. Although the percentage of MgO goes up to 45 p.c., the grades are different and prior to the use in Refractory Industry the picking and assorting will be necessary.

25. Manganese ore deposits of Sitapar-Kachidhana mine-area, Madhya Pradesh—A mineralogical and genetic study.

SUPRIYA ROY AND D. R. NANDY, Jadavpur.

Manganese ore deposits of Kachidhana, Sitapur and Gaimukh, Chhindwara Dt., Madhya Pradesh, occur interbedded with gondite, garnetiferous quartzite and feldspathic mica schists and are cofolded indicating syngenetic sedimentary nature. The rocks, along with the ore bodies, were regionally metamorphosed subsequently. The maximum temperature attained during metamorphism was around 500°C as indicate by quart-albite-epidote-almandine subfacies in the feldspathic mica schists. The paragenesis of the ore minerals for the whole area has been determined as follows :



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It is evident that the manganese ore bodies were originally laid down as sediments (principally MnO_2), which on metamorphism converted to the lower oxides like braunite and bixbyite and ultimately to metastable vredenburgite at the peak. Hausmannite exsolved in vredenburgite at the waning stage followed by transformation to bixbyite to second generation braunite and formation of hollandite, manganite and pyrolusite respectively. A peculiar observation was made that third generation braunite veins euhedral pyrolusites along and across the cleavages. Cryptomelane and second generation pyrolusite are entirely secondary. While the maximum temperature of 500°C attained during metamorphism can explain easily the formation of bixbyite, it is rather low for the formation of metastable vredenburgite. It is assumed, therefore, that the PO_2 was low enough to depress the transformation temperature of all the manganese oxide minerals and after the formation of euhedral pyrolusite a sudden lowering of PO_2 is postulated, which explains the formation of 3rd generation braunite.

26. Genesis of the Manganese ore bodies of Chikla-Sitasaongi area, Bhandara district, Maharashtra.

SUPRIYA ROY and FANINDRA NATH MITRA, Jadavpur.

The manganese orebodies of Chikla-Sitasaongi area occur at the contact of Sitasaongi and Mansar formations of Sausar Series. The orebodies are interbanded with gondites containing varying amount of rhodonite and are enclosed by peletic schists with which they are always conformable and cofolded into tightly pressed isoclinal folds. The field relations indicate that the manganese orebodies belonged originally to the same sedimentary sequence as the enclosing schists and subsequently suffered the same degree of metamorphism together. The different grades of progressive metamorphism in the peletic rocks such as biotite zone, garnet zone, staurolite zone and kyanite zone have been delineated in the field and thus the maximum temperature attained correspond to 600°C to 700°C. The paragenesis of the ore minerals from the whole area has been determined as follows : braunite I, bixbyite, vredenburgite, braunite II, hollandite, magnetite, pyrolusite and cryptomelane. The texture of the ores varies from schistose to recrystallised coarse gneissose according to the degree of metamorphism and the high temperature assemblages of ore minerals correspond to their peletic schist equivalents in the field. It is concluded that the manganese sediments as MnO_2, with the onset of metamorphism, converted to the Mn_2O_3 form and combined with silica and iron to form braunite and bixbyite. With highering of temperature near the peak, metastable vredenburgite and one-phase jacobsite formed at a temperature between 500° to 700°C (Mason, 1943). This value obtained by Mason from phase-equilibrium studies agrees well with the temperature attained by peletic schists. In the waning stage hausmannite exsolved in vredenburgite, followed by transformation of bixbyite to braunite and formation of hollandite and manganite respectively. Pyrolusite and cryptomelane are entirely secondary.

27. Mineralogy of the Manganese ores of Srikakulam district.

J. S. R. KRISHNA RAO, Waltair.

This paper describes the physical, optical and X-ray analysis of typical manganese minerals from Srikakulam district. The minerals are garnets (spessartites as well as spandites) rhodonite, manganiferous diopsides, Bustamites, Jacobsites, Braunite, Vredenbergite, Pyrolusite, Psilomelane (Hollandite, cryptomalene) and Bixybite. The associated minerals are haematite and magnetite.

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Subsequent to the formation of manganese ores, mineralization of insignificant nature is known as revealed by the presence of Pyrite, magnetite, Ilmenite and Molybdenite.

The type areas Koduru, Ramabhadrapuram, Chintalavalasa were critically reexamined for the validity of "Kodurites" as manganese intrusives but the cumulative mineralogical evidence favours otherwise of an originally impure, manganiferous sediment metamorphosed. The study brings out that 'Kodurite's is essentially a high grade metamorphic-rock.

28. The economics of the Limestone and Calc-tufa deposits of Hazaribagh district, Bihar.

S. N. P. SRIVASTAVA, Calcutta.

The author investigated the limestone and calc-tufa deposits in twenty-two localities covering the thanas of Hunterganj, Barkagaon, Ramgarh, Gola, Gomia and Mandu in the Hazaribagh district, Bihar. Limestones are mostly associated with the bands of phyllites or with the calc-silicate rocks. They dip either at moderate or steep angles. Except at two places the limestones are of crystalline variety with either white, greyish white with or without greenish tinge, grey, dark grey, dark or greyish white with yellowish bands. They occur either as veins, lenticular patches or in bands. Individual bands on the average are 2 to 5 feet (or 0·6 to 1·5 metres) thick. The largest of the limestone occurrences is that of Bachra-Hosir which is about 2 miles (or 3·2 kms.) long nearly east-west and extends on either end into Ranchi district.

The following deposits of limestone forming different units appear to be of possible economic importance and can be exploited for cement making :—

Unit No. A	(1) Bachra	4,213,000 tons
,, B	(1) Baskudra-Suiyudih (2) Bundu-Basaria (3) Kurkuta-Religara	13,760,000 tons, of which No. (2) and (3) have a reserve of 7,040,000 and 6,000,000 tons, respectively.

The additional reserves of 3,43,900 tons taken together from Deoria, Chikor, Kori and Ladi can constitute additional reserves for the deposits in unit No. B.

Unit No. C	(1) Ghangrijaratoli (2) Korambe (3) Sondimira (4) Upar Barga	3,238,700 tons, of these No. 1 and 3 themselves have a reserve of 2,933,200 tons.

The reserves have been assumed upto a depth varying between 20 to 100 feet (or 6 to 30 metres).

Taking all the above units together, the results of the chemical analyses of limestones are as follows :—

	CaCo3	MgO	R2O3	Insolubles
Maximum	86·45%	1·45%	1·19%	26·28%
Minimum	73·23%	0·30%	0·40%	11·14%

It may be noted that the above groupings are only tentative and a more detailed examination of the deposits with close sampling will be required before

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making any attempt at exploration or before any scheme is proposed for setting up a cement plant.

29. A study of the red shales of Bichagatia and surrounding areas in north Cuttack district, Orissa and its suitability as a natural mineral pigment.

KUMAR BANERJEE, Jadavpur.

The red shales intimately associated with the iron ores of Bichagatia (21°56′ :85°56′30″) and surrounding areas belong to the iron ore stage of the Iron Ore Series.

It attracted the notice of the author particularly due to its warm iron red hue and attention was further focussed on its probable usefulness as natural mineral pigment.

After careful study of the material in the field it appeared that most of the argillaceous shales lay within the faulted zone of the area.

The physical properties of the shales were studied with particular stress on colour and particle size. A general observation was made to test its tinting strength, oil suspension and emulsion capacities, hiding power, opacity and mass colour.

The chemical analysis indicated an average of 41%—50% Fe_2O_3; 15%—25% SiO_2; 20%—40% Al_2O_3. No accompanying colour ingredients were detected. The study indicated that the shales were reasonably suitable as a natural mineral pigment.

30. A contribution to the problem of genesis of 'Blue Dust' in the sedimentary iron ores of Bihar and Orissa.

ASOKE CHATTERJEE, Jadavpur.

Samples of 'blue dust' were collected from the Noamundi Iron Ore Mines (22°8′N and 85°30′E) and also from several other iron ore mines in Bihar and Orissa. The powdery variety of iron ore is generally blue-black in colour and hence the terminology. Chemical analysis of the samples placed the Fe-content of the ore between 65 and 70 per cent. In the identification of the ore minerals, physical properties like streak, hardness, specific gravity and magnetism were more useful than the optical properties. Study of the ore minerals in reflected polarized light was not easy due to the difficulty encountered in preparing polished sections. Hematite, being the major constituent of the ore, is associated with varying proportion of martite. The individual crystals are mostly perfect in themselves; but they do not have any mutual coherence and hence the extreme friability of the substance.

Detailed laboratory experiments were carried out on the problems of solution, precipitation and dehydration of iron oxides. On these experimental evidences, supported by field evidences, it is considered reasonable to describe the present powdery state of the substances as the dehydrated residue of a parent hydrate phase. It may be assumed that dehydration of the parent hydrate crystal gave rise to a dehydrated ionic network. The structure being unstable underwent rearrangement to give a new phase.

A further rearrangement may occur in this disorganized material giving crystalline nuclei of still another phase. The process is accelerated in the presence of water vapour.

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31. A note on the petrological characters and their significance of coals from Umaria, Madhya Pradesh.

BANKIM MUKHERJEE and KAMAL CHAKRAVARTY, Jadavpur.

Coal seams around Umaria (Lat. 23°31′ and Long. 80°50′), Madhya Pradesh, occur in Barakar formation. There are six seams of which two are worked, others are of poor quality.

Channel samples of coal, collected from the working seams II and III were subjected to chemical and petrological analyses under carefully controlled conditions. The quantitative petrological analysis was expressed in terms of three group macerals—vitrinite, exinite (including resinite) and inertinite (fusinite, semifusinite and micrinite). The average of several analyses are given in the table below :

	Proximate Analysis.					Petrological Analysis			
	Moisture %	Volatile matter %	Fixed Carbon %	Ash %	Caking or non-caking	Vitrinite %	Exinite %	Inertinite %	Visible mineral matter %
Seam II	2·66	13·45	54·73	28·65	Non-caking	31·39	17·26	36·16	14·89
Seam III	10·00	28·78	45·91	15·26	Non-caking	40·93	35·88	20·68	2·50

The quantitative petrological analysis which exhibit both inter- and intra-seam variations were subjected to statistical analysis on methods of Snedecor (1946) to see whether these variations were inherent or not. Contingency chi-square test was also applied since the distribution was discrete. The general conclusions arrived at are (1) The difference in the composition of the two seams depends mainly on their exinite and inertinite contents, (2) Inherant variation in seam II is attributable to the exinite content, and is brought about by igneous intrusion, (3) High inertinite and low exinite content and the presence of vitrinites of higher reflectivity reveal the fact that seam II has been affected by igneous intrusion, (4) Low exinite content seem to be responsible for the low volatile matter content of seam II and reverse applies to seam III which is normal coal, (5) Non-caking characters of these coals are due to the absence of the typical type of vitrinite influencing caking.

32. A note on the geochemical prospecting for copper between Turukocha and Nandup, Singhbhum copper belt, Bihar.

S. K. BOSE and J. G. K. MURTY, Calcutta.

The paper deals with the results of the reconnaissance geochemical soil sampling which was carried out in a 12½ mile long belt between Turukocha and Nandup during 1957-58 season to delineate potential copper rich zones.

The area between Rajdah and east of Mandup is occupied by chlorite mica schist, constituting the main rock type of the shear zone, besides the sheared conglomerate bands. The shear zone rock types in this area are characterised by apatite-magnetite mineralisation. The traverses were laid 1,000 feet apart (approx.),

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across the strike of the rock formations in the mineralised shear zone of the belt and the samples collected from an average depth of 9 inches below the humus zone at 25/50 feet interval. The copper values in soil samples varied from 50 to more than 4000 P.P.M. against the background of 50-100 P.P.M. The width of the anomaly zones varied from 50 to 350 feet. Few samples collected from deeper depths (15 inches) gave more encouraging results and appeared to be more reliable, specially from areas with thicker soil cover. Some of the samples showing high copper content were analysed for nickel to be of assistance in shortening the zones of anomaly for copper to narrower limits. The values for nickel range between 50-250 P.P.M. and were seen to correspond to the major peak anomaly zones of copper. The geochemical anomalies bear a close relation to the self potential and magnetic indications.

A study of the geochemical results coupled with geological data suggest that there are two copper rich areas in this part of the belt, viz., at Rajdah and Ramchandra Pahar. In Rajdah area there appears to be only one lode (may not be continuous one) whereas in Ramchandra Pahar area there are three principal lines of old workings which are quite extensive and appear to suggest the existence of at least three lodes, the extent of which is not known at present.

33. Fossil Ostrea from the Dwarika Beds of Gujerat State.

B. NATH, Patna.

In a visit to Dwarika, in October, 1960, the author came across a fossiliferous bed from which about two dozen fossils of *Ostrea* were collected.

From a morphological study, two species of *Ostrea* have been distinguished :—

1. Ostrea multicostata and 2. *Ostrea-bellovacensis*.

Dr. Fedden has separated Dwarika beds from the Gaj bed on account of mineral characters and absence of Gaj fossils. But it is of great interest to note that the fossil Ostrea *multicostata* of Gaj bed is found in the Dwarika beds. The other species closely resembles Ostrea bellovacensis of the Upper Ranikot Zone No. 3.

Both the species therefore are of great palaeontological interest.

34. On the Generic classification of some "Orthoceras" from India, Burma and Pakistan.

S. S. SARKAR, Calcutta.

While studying some *Orthoceras* from the Triassics of Kashmir, the author came across a number of incomplete identifications of *Orthoceras* scattered here and there in the GSI palaeontological literatures. These uncertain specific as well as generic determinations are somewhat vexing and the author first of all has made an attempt to classify generically some *'Orthoceras'* figured from India, Burma and Pakistan. Of course, this is the first attempt in this respect and a great hindrance to this end has been that, some important foreign Monographs and publications are not available in the GSI Library or elsewhere in this country and the author had no other alternative but to rely upon some reproduced versions given by some later workers.

The following are the Genera represented and the author has discussed each time in the original paper the points supporting the classification :—

I. *Kionoceras* sp. ind.
=*Orthoceras sp; ind.* Diener, 1915, from Kanaur, Pl. XI fig. 4, Pal. Ind. N.S. Vol. V, Mem. no. 2.

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II. *Protocycloceras cyclophorum* Waagen from Salt Range.
=*Orthoceras cyclophorum* Waagen, 1879.
Pl. VI figs. 7 & 8, Pal. Ind. Ser. XIII, Vol. 1.
=*Orthoceras cyclophorum* Waagen
No. fig. page 54, Pal. Ind. N.S. Vol. XVII, F.R.C. Reed, 1931.

III. *Michelinoceras* Foerste, 1932.
1. *Orthoceras regulare* (Schlotheim) *in* F.R.C. Reed, 1917, from Yunnan, Pl. V figs. 13, 13a, Pal. Ind. N.S. Vol. VI, Mem. 3.
2. *Orthoceras cf. scabridum* Angelin from Yunnan, Pl. V fig. 14, Pal. Ind. N.S. Vol. VI, Mem. 3, F.R.C. Reed, 1917.
3. *Orthoceras aff. laterale* Phillips from Northern Shan States, Pl. XVIII, fig. 13, Pal. Ind. N.S. Vol. II, Mem. 5, F.R.C. Reed, 1908.
4. *Orthoceras sp. ind.* from Upper Burma, Pl. VII fig. 14-Pal. Ind. N.S. Vol. II pt. 3, F.R.C. Reed, 1906.
5. *Orthoceras sp.* from Yunnan, F.R.C. Reed, 1917, Pl. V fig. 16, Pal. Ind. N.S. Vol. VI, Mem. 3.

IV. *Leurocycloceras* Foerste 1928.
=*Orthoceras oblique-annulatum* Waagen, 1879, from Salt Range, Pl. VI, figs. 9-10, Pal. Ind. Ser. XIII, Vol. 1.
=Orthoceras cf. annulatum Sowerby ? from Central Himalaya, Pl. XX fig. 13, Pal. Ind. Ser. XV, Vol. VII, Mem. 2.

V. *Geisonoceras* Hyatt 1884.
=*Orthoceras aff.* eichwaldi Barr. from Burma, Pl. X figs. 6, 6a-Pal. Ind. N.S. Vol. VI, Mem. 1, F.R.C. Reed, 1915.

VI. *Paracycloceras Gen. nov.* Sarkar.
=*Orthoceras* (*Protocycloceras* ?) *departi,* F.R.C. Reed, 1917, Pl. V figs. 15-15b, Pal. Ind. N.S. Vol. 6, Mem. 3.

35. The early forms of *Nautilus pompilius* Linne, 1757.

S. S. SARKAR, Calcutta.

The fossil *Nautilus* and the living *Nautilus* establish a link between the Palaeontologists and Neontologists. The living *Nautilus* also throws much light on the fossil Cephalopoda. The author had been interested in tracing the early forms of this living Indian Ocean species from the geology of India and other adjoining countries :

In 1873-76 William Waagen while examining the Jurassic Fauna of Cutch (Pal. Ind. Ser. IX, Vol. 1) discovered a new species—*Nautilus intumescens,* which he remarked, was most nearly allied to the living *N. pompilius* L. The author had examined this species (GSI Type specimen No. 1893) described by Waagen and was struck by the resemblance this Jurassic species showed to the present day *Nautilus.* Waagen had placed this species along with *N. pompilius* L. in the group of *Simplices* of Quenstedt; while *N. pompilius* L. falls under the group of *Laevigati* or *Nautili* in the classification of d'Orbigny adopted and highly recommended by Blanford (1865) while describing the Cretaceous Cephalopoda of South India. As the author has not yet handled *Nautilus* fossils extensively he is not yet in a position to speak on the above two classifications.

The Tertiary species *Nautilus subfleuriausianus* d'Archiac, has got a close resemblance to the present day species of *Nautilus.* The author had examined carefully all the following figures lying under this species : The figures given by Cossman and Pissaro, 1909 (Pl. I, figs. 1-4, Pal. Ind. N.S. Vol. III, Mem. No. 1,

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pt. 1, GSI Type No. 10,779) have got no resemblance to *N. pompilius* so also the Figs. 1 & 2 of Pl. II of Vredenburg, 1929 (Pl. I figs. 1, 4, Pl. II figs. 1-2; Pal. Ind. N.S. Vol. X, Mem. IV, GSI Type No. 13,209). Out of the four figures, only figs. 3 & 4 in Pl. I of Vredenburg bear a striking resemblance to *N. pompilius* L.

A comparative study of the three following forms on the breadth is to length ratio was made and the Fig. 3 (Pl. I of Vredenburg) has almost the same form as that of *N. pompilius* L., besides there is a close resemblance of suture, umbilicus etc. between the two :

1. *N. intumescens* Waagen, 1879 ... ... 77·9 %
2. *Nu. subfleuriausianus* d'Archiac, 1929 (Pl. I fig. 3 of Vredenburg) ... 72·1 %
3. *N. pompilius* Linne, 1757 (Fig. 135, page 305, Woods, 1950) ... 72·06%

36. Human and Vertebrate sutures for specific determination in fossil and living forms.

S. S. SARKAR, Calcutta.

Sutures play a very important role in the Ammonoids. While a group of Invertebrate palaeontologists stress mainly on sutures for specific and generic distinctions, there are other workers who do not agree to that extent and are inclined to give the prime importance on the outer ornamentation and characters. The author wanted to know how the Human Vertebrate sutures reacted in the specific differentiation. So far, some Physical Anthropologists had only been investigating upon—Suture Closure, which might be called on the other hand, the study of the ontogenic variation of suture; to assess the age at death of skulls.

Sutures are immovable lines of junction between the bones of the Human Vertebrate skull and in the Ammonites, it is also the lines of junction of Septum with walls of shell.

As it appears, no attempt has been made before in this field and the author carried some investigations on the Human and Vertebrate Sagittal sutures. He first started from two known Human species—the Sinanthropus skull and the Rhodesian skull. After subdividing them properly into : S1, S2, S3 and S4, he compared them side by side. While the Sinanthropus Verticis, S2 (13 lobes) is simpler in nature, it is of a very complicated pattern in the Rhodesian S2 (8 Lobes) and is also 1 cm. longer than the former. These show clearly that they are not the same species but quite different from each other. The other variations in S1, S3 and S4 have not been discussed here.

The author made another investigation on three skulls from three different Human races, e.g. Chinese, Mediterranean and Bengali (as no good Negro skull could be obtained). This investigation also proved satisfactory as explained by sketches of the Sagittal sutures made direct from the skulls.

As regards fossil or living higher vertebrates (Mammals) no good specimens with preserved Sagittal suture of two related or adjacent species could be obtained for a close comparison. The author tried however, upon some well preserved species of *Macaca* and shows that the results do not speak in the negative.

This is a preliminary attempt on the role of sutures, particularly the Sagittal suture. The author believes that sutures can be of help in this field.

As regards Man, there are at least 50 *Homo* species created. According to Boule and Vallois most of the determinations should fall in synonymy. The author suggests a revision and classification of these 'Species' on the basis of a cranial suture, e.g. Sagittal Suture, as these 'Species' have been erected on some or other physical characters.

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37. Assilina from the Eocene Rocks of Garo Hills, Assam.

BIMAL KUMAR SAMANTA, Calcutta.

Eocene rocks of Garo Hills, Assam are made up of Tura, Siju and Kopili formations in ascending order. The sequence is conformable. Assilina occurs only in lower part of the Siju Limestone formation (Middle-Upper Eocene). A thorough study of these Assilina-limestones reveals the presence of following forms : Assilina regularia Ghose emend. Samanta, A. regularia sijuensis n. var., A. subassamica Samanta, A. subassamica sijuensis n. var., A spira corrugata De la Harpe, A. spira taikhamensis n. var. A. subspira De la Harpe, A. subspira corrugata n. var A. simsongi n. sp., A. subsimsongi n. sp., A. exponens Sowerby and A. mamillata D'Archiac.

A study of various species of Assilina described from Middle to Upper Eocene rocks of India and Pakistan shows that they can be classified into two groups on the basis of prominence of marginal cord and rate of opening of spire. Thus A. spira, A. irregularis, A. papillate, A. regularia and their corresponding megalospheric forms differ fom A. exponens, A. rota, A. cancellata and their corresponding megalospheric forms in having prominent marginal cord and rapid rate of opening of spire.

(v) Stratigraphy

38. Revised Stratigraphic Succession of the Iron Ore Series Rocks in South Singhbhum-Keonjhar Region.

S. N. SARKAR, Dhanbad, M. N. MAHAPATRA, New Delhi, and K. C. SAHU, U.K.

Intensive stratigraphic and structural work in Joda-Gurda-Noamundi region, reconnaissance in the surrounding key areas and reinterpretation of the earlier data have necessitated the following revision of the stratigraphic succession of the Iron Ore Series in this type area. Systematic tectonic analysis show the structure of this series in the region to be a low NE plunging synclinorium, overturned towards SE, and the top and bottom criteria indicate the eastern limb as the normal one

Revised succession

		Newer Dolerite
Kolhan series	...	Kolhan shales
		Kolhan limestone (impersistent)
		Kolhan sandstones and conglomerates
		Unconformity
		Singhbhum granite
Iron ore series	...	Upper shales and phyllites, sandstone, lavas
		Banded hematite jasper with iron ore
		Lower shales, phyllites and tuffs
		Basal sandstone with conglomerates
		Unconformity
		Older Metamorphics : Mica-, sillimanite-, hornblende-, chlorite- and quartz schists,

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39. Banded Ferruginous Quartzite near Saundatti.

Miss K. R. GHAISAS, Poona.

This paper contains an account of some bands of banded ferruginous quartzite occurring in the neighbourhood of Saundatti, a Taluqe town in the Belgaum district of Mysore State.

The tract under consideration lies midway between the northern extremeties of the main Dharwar band and the Gadag band.

The following are the Dharwarian rocks occurring around Saundatti, arranged in their order of importance :

(1) Epidiorites and Hornblende schist.
(2) Chlorite-phyllite.
(3) Hornblende-biotite-schist.
(4) Banded ferruginous quartzite.

Banded ferruginous quartzite forms almost a negligible portion of the Dharwarian rocks around Saundatti. Beds of small size were noticed in three places (1) North of the village Gorvankol, (2) About a mile to the north-west of Saundatti close to the east of the Saundatti-Manoli road near the milestone 5/6, (3) the hillock of Saundatti where the drinking water reservoir is built.

The rocks found at all the above places are lithologically similar, and are composed of alternating layers consisting of chiefly of quartz and iron ores such as haematite and magnetite. The beds are not themselves folded, but laminae occurring in some middle portions of the beds are wavy or even crumpled and contorted and many of them are recumbant. The folds or contortions do not exhibit any order and die out near the top and bottom of the beds. But even when wavy or crumpled or recumbant, the laminae maintain their parallelism.

The rocks on the whole are poor in iron, the siliceous portions of the rocks consist of quartzites, fine to coarse grained and with mosaic or sutured textures.

It appears that both the siliceous and accessory minerals were originally detrital material i.e. ordinary sediments coming from the waste of some terrestrial rocks, such as basic lavas, tuffs and sills—which could easily furnish apatite or epidote. The actinolite could have come from sills or other intrusions in which much actinolite was produced in the late or deuteric stages. These evidences show that the rocks owe their origin to sedimentary processes and not to metasomatic or any other processes.

40. Stratigraphic Position of the Shear Zone Rocks to the South of Tatanagar, Singhbhum Dt., Bihar.

A. K. BANERJI, Calcutta.

The shear zone, to the south of Tatanagar, is bounded by two shear planes to the north and south respectively and encloses a group of rocks that vary in thickness from about two miles at the eastern part to about three miles at the western part of the area studied. The shear zone is bounded by the Chaibasa stage of rocks to the north and the Iron Ore stage of rocks to the south. Present studies indicate that the rocks within the shear zone consist of a thin slice of Chaibasa stage rocks to the north and a thin slice of Iron Ore stage rocks to the south. Between these two slices occur a group of rocks that are correlated with the Dhanjori stage. These rocks are separated from the slice of Iron Ore stage rocks by a band of thin but impersistent conglomerates and thus occupy a position stratigraphically similar to the Dhanjori rocks. Moreover these rocks consist of metamorphosed equivalents of shales, sandstones, lavas and conglomerates and are

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therefore lithologically similar to the Dhanjori rocks. It is suggested that the Dhanjori rocks extend westward beyond Narwa Pahar which is commonly believed to be the western limit of the Dhanjori basin.

41. Geology and mineral resources of the area around Pal Tashil, Surguja District, Madhya Pradesh.

G. K. MODAK, Calcutta.

An area of about 337 square miles between latitudes 23° 32′ 30″ and 24° 0′ and and longitudes 83° 30′ and 83° 44 30″ in parts of Surguja district of Madhya Pradesh was mapped on the scale of one inch to one mile on survey of India topo sheets 64 M-9 and 64 M/10 with a view to locating occurrences of minerals of economic importance.

The area consists of Archaeans, Lower and Upper Gondwanas.

The Archaeans are represented by ancient crystalline gneissose (including various types of granite gneisses) and garnet-staurolite-hornblende bearing schistose rocks and quartzites. Granite gneisses are traversed by innumerous ramifying quartz and pegmatite veins and also by dolerites of all dimensions.

The Lower Gondwanas are represented by the Talchir boulder bed, laminated khaki green or olive green and also pale pink sandstones interbedded with shales or shaly bands and *coal* bearing Barakars made up of sandstones and shales.

The Upper Gondwana rocks of the area are characterised by the Mahadeva (?) sandstones forming prominent hill masses and hill ranges.

The boundary between the Archaeans and Gondwanas appear to be a faulted one (?) as also the boundary between the Barakars and the Mahadeva.

There are several coal seams of low grade and inferior quality. There are also a number of Hot Sulphur Springs (about 23 in number) recorded in a fault zone in the neighbourhood of Tattapani (23° 41′ : 83° 40′), about ten miles south of Ramanuj Ganj (23° 48′ : 83° 42′ 30″).

42. Geology and correlation of the Indravati Series of Bastar District, Madhya Pradesh.

N. V. B. S. DUTT, Calcutta.

The paper embodies the geology of the Purana formations of the Bastar district, Madhya Pradesh, and their correlation on lithological, successional and structural considerations with the Kurnools of the type area and the Puranas of Chhattisgarh and the Godavari valley. The Puranas of Bastar present a conformable series, which is designated as the Indravati series after the river draining the major outcrop. Their stratigraphic sequence in ascending order, namely, (1) Tiratgarh subarkose and orthoquartzite, with shales towards the top, (2) Kanger limestone, and (3) Jagdalpur shale and shaly limestone, with calcareous bands in the lower portion and siliceous bands mainly in the upper part, is established.

The Tiratgarh quartzite is correlated with the Paniam, the Kanger with the Koilkuntla, and the Jagdalpur with the Nandyal, of the Kurnool system. They are correlated in the same order with the Chandarpur subarkose, the Charmuria limestone, and the group of Gunderdehi shale, Khairagarh sandstone and Raipur shale and shaly limestone, of Chhattisgarh. The Khairagarh would be represented in Bastar by the siliceous layers intercalated in the lower part of the Jagdalpur formation.

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A tentative correlation of the Tiratgarh with the Sullavai and of the Kanger with the Upper (? Sullavai) limestone is suggested. In view of the absence of clear unconformity between the Pakhals and the Sullavais (Heron, 1949), it appears the Pakhal quartzites and the Penganga limestones and shales might be correlated with the Banganapalles and the Jammalamadugus respectively.

43. A reconsideration of the Stratigraphic position of the Chrome-serpentine Rocks of Kankauli and Vagda, Ratnagiri Dist., Maharastra.

PRABIR KUMAR GUHA, Jadavpur.

The ultrabasic intrusives of serpentine containing chromite outcrop at Kankauli (16° 16′, 73° 45′) and Vagda (16° 14′, 73° 45′) in the form of dyke-like bodies. They were first studied by Ghosh (1933), and then by Iyer (1939). Detailed work on these rocks by Chakrabarty and Guha (1960), showed that these rock bodies cut across the foliation of the granite-gneiss of Archaean age. The granite-gneisses are intimately associated, and intrusive into the Dharwarian schists and gneisses. Hence the chrome-serpentine rocks together with the intimately associated Dharwar and Archean system of rocks can definitely be postulated to be pre-Cambrian age.

Iyer (1939), however, in his stratigraphic classification of the region, places the metamorphic rock types, now accepted as Dharwars, in upper Kaladgis (Cuddapah). He has not acknowledged the existence of Dharwars in this tract, which leads him to predict a post-Cuddapah age for the chrome-serpentine rocks.

From detailed investigations in the field, the author feels that the chrome-serpentine rocks, apart from being pre-Cambrian, are also pre-Cuddapah in age.

44. Geology and structure of parts of Visakhapatnam District, Andhra Pradesh.

A. SRIRAMADAS, M. S. MURTY and R. V. RAMARAO, Waltair.

Variation in structural trends from N.W.-S.E. through E.-W. to N.E.-S.W. is noticed during the mapping on four inches to a mile scale of about 30 square miles area located in between latitudes 17° 40′ and 17° 42′ and longitudes 83° 2′ 30″ and 83° 15′ near Gazuvaka in Visakhapatnam District of Andhra Pradesh.

The geological formations met with in the area are the khondalite series consisting of the garnet sillimanite gneisses, the garnetiferous quartzites and the quartzites, the charnockites and the porphyritic feldspar granite gneisses.

The N.W.-S.E. structural trends of the area are parallel to the Mahanadi strike, although the area forms a part of Eastern Ghats which have N.E.-S.W. trend. The presence of plunging folds, drag folds and the criss-cross pattern of the jointing show that the area was subjected to extensive tectonic disturbances.

Studies are in progress to analyse the tectonic forces that affected the area.

45. Geology of the Gollapalli area, with special reference to the Sedimentary formations.

B. B. G. SARMA, CH. V. RAJU and A. V. MURALI, Waltair.

The Gopalli area (northern part of G.T.S. Sheet No. 65 D/14) is the home of Gollapalli sandstones, a stage in the Gondwana system of rocks along the east coast of India. However, since the publication of King's classical memoir (1883), there has not been any detailed work on this area. The present investigation

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aims at a detailed mapping of the area (16° 39′ : 16° 45′; 80° 49′ : 80° 59′) on a 4″ to a mile scale, followed by sedimentological study of the formations.

The rock units met with are as follows :

Lithology	Local name	GSI classification	Age	Strike	Dip
Conglomerates; unfossiliferous, dark, coarse, ferruginous sandstones	Rajahmundry sandstones	Cuddalore sandstones	Oligocene-Miocene	Horizontal	—
Fossiliferous dark brown sandstones and shaly sandstones	Gollapalli sandstones	Rajamahal	M. Jurassic	N.E.-S.W.	5-10° S.E.
Quartz-garnet-sillimanite gneiss and quartzites	Khondalite	Archaean	Archaean	NNE-SSW	70-80° ESE

The units are separated by conglomerate beds of varying thickness.

Compressions of equisetale stems from the Gollapalli sandstones are found and identified. This constitutes the first report of their occurrence from this area. Similar fossils have been reported earlier (1960) from the Nuzvid area to the north.

The Gollapalli and Rajahmundry sandstones are characterised by the following average values for their median, sorting coefficient and sphericity : 0·28 mm. and 0·478 mm., 1·441 and 1·393, and 0·625 and 0·710. A higher energy level for the depositional environment of the Rajahmundry sandstone is thus indicated. The heavy mineral suites point in general to the khondalite suite of rocks as the provenance. Presence of corroded boundaries for some minerals in the Gollapalli stage, and occurrence of a greater number, as well as some of the unstable species, of heavy minerals like epidote and hornblende in the Rajahmundry standstones, indicate the possible action of intrastratal solutions.

46. A Note on the Cretaceous Rocks of the Western Khasi Hills, Assam.

M. V. A. SASTRY and A. M. KHAN, Calcutta.

The paper deals with the detailed study of the systematic collection of fossils made by the authors from the Upper Cretaceous rocks of the Balat-Gumaghat area of the Western Khasi Hills, Assam. The basal beds constitute massive, coarse, felspathic sandstone with irregular bands of ferruginous sandy shales which are highly fossiliferous. These are conformably overlain by the fossiliferous glauconitic sandstone beds. The study reveals that the Cretaceous beds of this area could be correlated with that of Mahadev stage of the adjoining Thariaghat area. The fauna includes, in addition to already known forms, *Panopea, Tellina, Pinna* and a few others which are recorded for the first time from the Cretaceous beds of Assam. The following arenaceous foraminifera are also noted. *Haplophragmoides haplophragmoides* Eggeri, *Ammobaculites juncens* Cushman and Applin, *Turritellela* sp., *Spiroplectammina bentonensis* Carman and *S. navarrona* Cushman.

The faunal assemblage suggests a horizon equivalent to that of the Ariyalur stage of South Indian Cretaceous, indicating a Maestrichtian age.

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47. An unreported Band of Raghavapuram Shales from Duddukur area, Andhra Pradesh.

B. B. G. SARMA and V. RAMESAM, Waltair.

The Duddukur area (South-western part of G.T.S. Sheet No. 65 G/12) was geologically mapped earlier by King (1883), Venkayya (1947), Apparao (1950), and Krishnan (1951). The formations reported are as follows :

Alluvium ...	...	Recent.
Oligocene-Miocene	...	Rajahmundry sandstones and conglomerates.
U. Cretaceous & Eocene	...	Deccan traps with intertrappeans.
Cretaceous ...	...	Infratrappean sandstones and shales.
U. Jurassic ...	...	Tirupati sandstones.
M. Jurassic ...	...	Gollapalli sandstones.

A recent survey of the area on the scale of 4″ to a mile revealed the presence of a band of shales and clays occurring between the Tirupati sandstones and Gollapalli sandstones, the band roughly running east-west. Outcrops are met with in the village of Yelachintalgudem (17° 6′; 81° 33′ 30″) and half mile north of Peddapuram (17° 6′; 81° 34′ 15″). The shales are variegated in colour, with a maximum thickness of 40′ and dip at 20° S.E. generally. Imperfect leaf impressions are found and identified as belonging to the form genus Taeniopteris. The lithology, fossil content and stratigraphic position leads one to conclude that these shales and clays belong to the Raghavapuram stage of the Gondwana system of rocks.

As the Raghavapuram shales are generally believed to be of marine origin, this report is of significance as it indicates a marine transgression following the continental Gollapalli stage in this area.

(vi) Structure Tectonics

48. Stages of Structural Growth of the Peninsular India.

R. P. SINGH, Patna.

The Central protruding stable landmass of Asia in the Indian Ocean forms the Indian Peninsula but its build, structural layout and facial expressions eloquently speak about its ancient anchorage with the super-continent of Gondwanaland.

The framework of the Peninsular India can be understood in terms of the attitude of rocks which add to the variety of structural features from horizontality to verticality with reclining posture and from simple wrinkling to magnificient contortions of nappe, pitching anticlines, anticlinorium and synclinorium. The major plans of its making go back to far distant period of diastrophism, effusion and enstatism.

The author outlines the possible stages of its structural development. The structural base of the Peninsular massif is provided by a series of batholithic intrusions of granites, gneisses and charnokites into highly metamorphed Dharwar strata. The Dharwar appears in their denuded state. The Archaean denuded surface, covered with Cuddapah and Vindhyans, is torn in a linear fashion perhaps in sympathy with the Hercynian Revolution where glacio-fluvial, lacustrine detritus found a comfortable corner and is also burried beneath the Cretaceous Rajmahal and Eocene Deccan trap lavas.

The chapter of Jurassic and Cretaceous inroads of seas explains the horizontal structures of Cutch, Trichinopoly, Bagh and Lameta.

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The shield registered epeirogenetic reactions in sympathy with the Tertiary Revolution. This finds an expression on its face in the form of uplift tilt, warp, and even depression.

49. Shear emplacement of thin limestone bands along Granite Contact, East of Kharwa (26° 11′ : 74° 26′) Rajasthan.

SUGATA SEN GUPTA, Calcutta.

In this area, Dr. Heron mapped a group of Delhi metasediments in contact with Pre-Aravalli Granite. Here two thin (30′-100′) linear belts of marble are found to intervene between them. All the contacts are sharp and straight. The bands trend N40°E on average, showing a tendency to merge with the main belt of 'Ajabgarh Marble' towards SW from which they are separated by a thin horizon of micaceous quartzite.

The marbles are vertically foliated. The foliation plane is parallel to its lithologic boundary and is extensively developed in all the adjoining rocks as a very good shear cleavage. Very often the quartzites are mylonized and the granite is changed to augen-gneiss or even to ultra mylonites. The thinner quartzite lenses within the marble bands are only fractured and slightly granulated, but where the quartzites dominate, it is converted to an extremely sheared quartz-schist.

The 'Ajabgarh Marbles' to the west of the shear zone often have thin long tongue like projections into the associated micaceous quartzites mainly along these shear cleavages.

The main marble horizon and the linear marble bands are lithologically identical. There is no visible effect of the granite on the marbles though they occur in close contact. These features besides the structures leads to the presumption that the marbles were possibly emplaced as 'cold intrusions' by shear gliding from the 'Ajabgarh' marble. The physical discontinuity between them may be due to the still later shearing along a N-S shear plane which is well developed within the intervening quartzite.

It is interesting to note that the mesoscopic folds and lineations away from these marble bands plunge to NE at moderate angles and the fold style shows a dextral movement whereas in the rocks adjacent to marble bands a SW plunging lineation is developed and if it is the transport axis, the sense of transport is sinistral.

50. Tectonic significance of the presence of more than one set of Lineations in Deformed Rocks.

S. S. MERH, Baroda.

Lineations in deformed rocks indicate important traces of movements and are very useful in deciphering the directions of tectonic transport in areas of deformation. Lineations develop parallel and normal (sometimes oblique also) to the direction of tectonic transport. Deformed rocks very often show two sets of lineations and in this paper the author has discussed the tectonic significance of such cases. First he has briefly described the mode of origin of various linear structures like slickensides, minor folds, mullions, quartz rods, lineations due to stretching and due to cleavage-bedding intersection. Later on he proceeds to discuss the various ways in which rocks develop two sets of lineations. More than one set of lineations in rocks could be due to (i) one single deformation, (ii) two deformations and (iii) several deformations. Even though an area might have undergone more than two phases of deformation, it is very rarely that the

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rocks at one single spot contain lineations belonging to all the deformations. Depending on the rock types, overall structural pattern and the variations in the intensity of the different episodes in different parts of the ground, from place to place, lineations belonging to different generations might exist in pairs in various combinations, but never exceeding two at one spot. Thus in areas of repeated deformations, the field investigations should, in addition to routine observations of lithological types, boundaries, foliation, cleavage and joints etc., consist mainly of a systematic mapping of linear structures. Subsequent statistical analyses of linear structures and a correlation of the results with other field and laboratory data, leads to a correct understanding of the structural geology of an area.

51. Occurrence of Crush-Breccia in Singhbhum Granite.

AJIT KUMAR SAHA and SHYAMAL KANTI CHAKRABORTI, Calcutta.

An interesting group of brecciated rocks, lying in a north-south trending zone (500 ft. × 250 ft.) has been observed near the village Phuphundi (86°7′ :22°35′) within the Singhbhum granite. The breccia is composed of sharply angular to irregular fragments (from microscopic dimensions upto boulders 2 feet across) of leucogranite, hornblende granodiorite, amphibolite, epidiorite and metagabbro, set in a highly comminuted mylonitic matrix containing quartz, plagioclase, actinolite, chlorite and sericite. The mylonitic ground mass shows schistosity dipping 70°-80° towards east, while the mineral foliation in the adjacent hornblende granodiorite dips 50°—60° towards north-east. Two dykes of unsheared Newer Dolerite cut across the zone of crush-breccia. The groundmass schistosity wraps around the smaller fragments (<1 mm.) and is crumpled against the larger fragments which show frequent marginal granulation. A similar elongated zone of brecciated rocks was found within the granites near Barasai (86°12′ :22°38′).

The elongated bodies of crush-breccia are considered to represent faults in Singhbhum granite. The matrix probably represents mostly granodioritic materials, but parts of it have clearly been incorporated by the crushing of other affected rocks. The generally unsheared nature of the larger fragments is partly explained by assuming that the fault movements occurred at considerable depth below the surface. The large variety of the rock fragments within the breccia probably indicates considerable vertical extent of the fault movements which are obviously of pre-Newer Dolerite age.

52. An Occurrence of Sandstone Dykes in the Upper Gondwanas near Perumber, Chingleput District, Madras State.

Y. K. AGRAWAL and K. V. S. RAM, Dhanbad.

Sandstone dykes, generally uncommon geological features in India, have been observed for the first time in the Sriperumbudur series of beds S.W.S. of Perumber railway station (Topo sheet 57 P/15, 12°22′, N 79°47′E). These are found in the bed of the Ongur river, west of the road bridge on it. These also extend westwards in their distribution to some 200 yards along the bed of N. Negungal river and S. Nedungal river. These exposures are continuous in a northerly direction and occur within the outcrops of shales west of the road between the Adylam and Ongur road bridges. The sandstone dykes do not have a definite trend but are haphazard in pattern and occur in shales. They cut the bedding of the shales in all possible directions. They are ½ inch to 6 inches in width, their length varying from a few to 10 feet. The wider dykes increase in general, in their

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strike length before they end abruptly against another sandstone dyke. They are also found to bifurcate. The dip of these dykes varies between 30° to 90° in different directions. The sandstone dyke pattern appears as criss-cross arrangement cutting one another. These dykes are reddish brown in colour and are composed of the same sandstone components that make up the sandstones of this area. These are fine grained, well consolidated and compact and as such they are more resistant to weathering and to the action of flowing water than the shales. The sandstone dykes therefore stand out 2 to 4 inches in relief above the shales. There is no stratification in the sandstone dykes. They occur more or less along the boundaries of the sedimentaries which indicates that these were formed in the shallow region of the basin of deposition. About the mechanism of intrusion, it has been suggested that due to some local earth tremors the wet sandy material was mobilised and pushed up from below into the cracks in the overlying shale where it consolidated as dyke.

53. Tectonic History of the Singhbhum Series North of the Copper Belt Thrust, Singhbhum.

S. N. SARKAR, Dhanbad.

Recent work in the key areas and reinterpretation of earlier data aided by reconnaissance lead to the following tectonic history of North and East Singhbhum between Dalma and Copper Belt thrusts. The Iron Ore Series of Dunn in this belt has earlier been renamed as Singhbhum Series (Sarkar and Saha, 1959, 1961).

In the first phase of the Singhbhum orogeny the rocks of the Singhbhum Series (including Chaibasa and Dhalbhum Stages) and Dalma synclinorium (B-folds), generally overturned towards south, due to a regional north-south vertical couple. Subsequently cross-folds or superimposed (B′) folds are developed at the western and south-eastern parts of the belt. Regional metamorphism during orogeny and development of Chakradharpur granite gneiss on the west and soda granite and granophyre on the SE by syntectonic granitisation at the core of the Singhbhum anticlinorium and Copper Belt thrusting along this core or important episodes.

On the western part of the belt sub-horizontal and westward plunging B′folds, which are generally overturned towards south, appear to be caused by a regional east-west sub-horizontal couple (with anticlockwise movement sense when viewed from above) due to resistance offered by a southern foreland against the progressive Singhbhum orogenic movement from the north.

On the south-eastern part of the belt NE/NNE trending B′folds overturned towards NW, Nichintapur—Gohala wrench fault-cum-thrust and other allied dislocations are developed by an ESE-WNW vertical couple (with anticlockwise movement sense when viewed from SSW) most likely due to the active control by the tectonic trend of the eastern border or basement or caused by an active NNE trending 'geo-fracture' or geosuture.

As Copper Belt thrust is considerably dislocated by the Nischintapur—Gohala fault which itself and the B′-folds are cut across on the north by the Dalma thrust, it is evident that the cross-folding movement continued even after the development of the Copper Belt thrust, and Dalma thrust post dates the cross-folds. From the critical consideration of all the available evidences the development of B and B′ folds and thrusts (with B″ structures) may be generally considered as three successive phases or episodes with some amount of overlapping and alternation between them during one long continued Singhbhum orogenic cycle.

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54. Determination of the Height of Pangaea Continent and the Age of Earth by the height and Surface Graph.

SHIVA KISHORE, Jullunder.

The author explains the double hump graph of the earth as due to the birth of the moon and removal of a large amount of upper rocks in the process. This is shown to produce two sharp lines in the surface height graph. With geological changes the sharp lines disperse to become two humps. The amount of dispersion therefore gives a measure of the age of the earth.

The large continents have large average height. The author has assumed that this is due to smaller erosion on large continent. The rate of erosion has been assumed to be inversely proportional to distance from sea. The erosion then comes to be proportional to $_1/\sqrt{A}$ here A is the area. Hence $H+\frac{K}{\sqrt{A}}$ should be constant for all continents and is equal to the original height and hence height of Pangaean continent. This height comes to about 1450 ± 50 meters for all continents from the present sea level. And thus taking the average the height of the Pangaea can be said to be 1450 meters.

(vii) Miscellaneous.

55. Mesas of Kasipur, Kalahandi District, Orissa.

S. ACHARYA, Cuttack.

Laterite cappings on the Chandgiri and other hills off Kasipur in Kalahandi District, Orissa have produced absolutely flat-topped hills, areas of which are quite considerable when compared to their heights. These geomorphic features which should be called as 'MESAS' are described in this paper. They have been produced by differential weathering of the streams activated by the rhythmic rejuvenation of a laterite-capped peneplain. The rejuvenation accentuated the down cutting of the rivers and consequently detached and completely isolated the lateritic blocks. Evidences in favour of rejuvenation have also been discussed in the paper.

56. Divergence of the surface water in the north Indian ocean with application to the location of upwelling and sinking.

V. V. R. VARADACHARI and G. S. SHARMA, Waltair.

Vertical movements of water known as upwelling and sinking in the sea, are closely related to the divergence and convergence of the surface waters. It would be interesting to locate the areas of divergence and convergence from a knowledge of the surface currents and to infer upwelling and sinking from the divergence pattern.

The paper presents some of the results of investigation on the location of the areas upwelling and sinking in the North Indian Ocean (between long. 55°E and 100°E) for the month of March, as deduced from the field of divergence of the surface waters. The divergence has been computed by a graphical method from the data on surface currents.

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The divergence field indicates strong upwelling off the east coast of India, being especially pronounced in its central part. There are some areas of upwelling off the east and south coast of Ceylon, the south coast of Arabia, and the coastal regions of the head of the Bay of Bengal. Strong upwelling is also indicated in the southeast Arabian Sea and some areas of the equatorial part of the Indian Ocean. The areas of sinking are located off the west coasts of India and Burma. Sinking is indicated also in some parts of the equatorial regions of the Indian Ocean and the central regions of the Bay of Bengal and the Arabian Sea.

57. A note on the ground water conditions of Gulbarga taluk, (Mysore State).

C. GOPALASWAMY RAO, Gulbarga.

The paper deals with the ground water conditions of Gulbarga taluk and its correlation to the associated Deccan traps. The distribution of underground water in this region, unlike in granitic terrain, is found to be quite regular and is confined only to the vesicular and amygdular flows. About 200 wells sunk in different parts of taluk were examined and the data regarding logs of well sections and the average depth of water table in each well were collected. The study of various levels in relation to water bearing strata has shown that the depth of water table reached varies in general from 40—70 feet in southern parts between 1200—1500 contours and 25 to 45 feet in the northern parts between 1600 to 2000 contours. The majority of wells have yielded potable water except in few cases where the water is rendered saline due to contamination of salts of subsoil.

58. Groundwater conditions at Panagarh base, district Burdwan, West Bengal.

SANATKUMAR BASU, Calcutta.

The note embodies the salient features of groundwater conditions of the area around Panagarh (23°27′ : 87°26′; 73M), Burdwan district, West Bengal.

Panagarh is situated on the almost flat to gently undulating alluvial plain built up by the Gangetic river system. The area around it is underlain by a succession of fluviatile sediments consisting of sand and clay. These formations are of recent age. From the study of available bore-hole cuttings it is found that sand is predominant over clay; it is fine to coarse in texture and occasionally mixed with gravel.

Groundwater in the area under study exists both in the unconfined and confined state. Water in the shallow zones occurs under water-table conditions, the water-table resting at a depth of 22—28 feet below ground level. Water occurring in the deeper zones is held under pressure, the piezometric surface varying between the depths of 14 and 28 feet from the land surface. From the analysis of available water level data the water table appears to have a gentle southeasterly slope. Piezometric surface rises considerably during the monsoon, the rise is evidently effected by greater monsoon recharge. Discharge of about 12,000 G.P.H. are common in many of 6-inch diameter tubewells with a drawdown of 6—8 feet down to a depth of 400 feet below ground level.

The chemical quality of groundwater tapped within this depth is very good, being characterised by a chloride content of 20 p.p.m. and 250 p.p.m. of total dissolved solids and is considered suitable for all normal domestic uses.

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59. Radioactivity of the rock types of Gazuvaka area, Visakhapatnam district, Andhra Pradesh.

K. VENKATA REDDY and R. V. RAMARAO, Waltair.

The Gamma activity in terms of equivalent Uranium per gram of rock of 6 garnet sillimanite gneisses, 3 acid charnockites, 3 leptynites, 1 intermediate charnockite and 1 porphyritic feldspar granite gneiss collected from Gazuvaka area is determined using a scintillation spectrometer. The radioactivity in terms of ppm of uranium for garnet sillimanite gneiss is in between 9·00 and 14·00, for acid charnockite between 35·00 and 39·0, for the intermediate charnockite 31·00, for leptynites between 19·5 and 28·00 and for porphyritic feldspar granite gneiss 20·0.

Studies are in progress to evaluate any possible discrepancies between alpha, beta and gamma activity of the same rocks.

60. C. M. Patterns of Siwalik Sediments.

A. T. R. RAJU and P. V. DEHADRAI, Dehra Dun.

The texture of a clastic sediment as characteristic of its environment of deposition has been observed by many workers. Siwalik sediments have been studied for their textural features in the Petrological Laboratories of the Oil and Natural Gas Commission and the present paper is based on interpretation of data obtained by the study of over 200 samples belonging to the Lower, Middle and Upper Siwaliks exposed in parts of Punjab (India). Data have been plotted to give CM patterns on the lines suggested by Passega (1957, Bull. Am. Assoc. Pet Geol. Vol. 41 no. 9), to bring out conditions of their deposition.

The study has suggested channel type, and tidal flat to shallow shelf conditions of deposition for Lower Siwaliks, fluviatile to flood-plain conditions for Middle Siwaliks, and Piedmont and fluviatile conditions for upper Siwaliks of Punjab.

61. Dielectric constants of limestones.

S. BALAKRISHNA, Hyderabad.

Dielectric constants and capacitances of a few limestone samples collected from the Huzurnagar area of Nalgonda District, Andhra Pradesh are determined by using a sensitive Q meter that has provision of a capacitance jig. The variation of the dielectric constants in the limestone samples are noted and the dependancy of the value on parameters such as the composition, porosity, grain size and density etc. is indicated. The dielectric constants of limestone samples studied are low and lesser than twelve and hence the possibilities of using them as a ceramic material is also considered, provided the other physical properties satisfy the conditions.

Ultrasonic Velocites in the same samples both longitudinal and tortional are determined and their variation is found to be connected with chemical composition, grain size, porosity etc.

62. Study of mid-rib orientation of fossil leaves, as an aid to determination of palaeo-current direction.

BANKIM MUKHERJEE and SAILENDRA NATH DAS, Jadavpur.

Sandy red shale beds of Barakar stge of the Sahajuri basin (Lat. 24°5′—24°10′N; Long. 86°49′—86°58′E) contain profuse plant fossil leaves of lower

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Gondwana flora (mostly Glosspoteris). The leaves are sufficiently elongated (of dimensional inequalities) to be considered as fabric element. The shaly beds were first oriented with reference to geographic north and then removed with shovel. Then the orientation of the leaf mid-ribs on the bedding plans was measured with the reference line and the data were grouped into 30° class interval. Measurements of mid-rib aximuth distribution of fossil leaves were made in three localities viz. Damagora quarry, Khun quarry and Bhowanipur incline.

The vector summation method for the treatment of orientation data has been followed to determine resultant vector azimuth (Θ), magnitude of the resultant vector (R). Rayleigh's significance test has been done to check the distribution against randomness. The probability (p) in each case was found out from the L% ($L = \frac{R}{En}$ 100) and total number of observation (n). Statistical measures of leaf mid-rib orientation is given below :

Localities	n	Θ	R	L%	p
Damagora quarry ...	128	175°18′	24·70	19·2	$<0·01$
Khun quarry	129	179°32′	45·63	34·8	$<10^{-5}$
Bhowanipur incline ...	112	147°0′	62·81	56·5	$<10^{-10}$

The result shows strong anisotropism in case of Bhowanipur ($p<10^{-10}$) and Khun ($p<10^{-5}$). The distribution at Damagora shows a somewhat less degree of anisotropism ($p<0·01$), still above significant level.

The preferred direction thus obtained indicates a palaeo-current approximately from North to South at Damagora ($\Theta = 175°18'$) and Khun ($\Theta = 179°32'$) and at Bhowanipur, approximately NW to SE ($\Theta = 147°$). The directions determined from sand-grain orientation give more or less the same result.

GEOGRAPHY

(i) Geomorphology

63. The Physiographic Regions of the Sagar—Damoh Plateau.

B. G. TAMASKAR, Amravati.

On the basis of geology, geomorphology, relief and drainage patterns, the plateau may be divided into the following physiographic regions and sub-regions :

I. *The North Central Highlands* :
   (a) The Dhamoni Hills.
   (b) The Tinsumal Plateau.
   (c) The Ghatia Upar.
   (d) The Ghatia Niche.

II. The North-eastern Plateau.

III. The Bearma Basin.

IV. The 'Haveli' or the Sonar-Kopra Doab.

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V. *The South-eastern Highlands* :
- (a) The Jabera Basin.
- (b) The Mohli and adjacent group of hills.
- (c) The Bhander Hills.
- (d) The Kaimur Hills.

VI. *The Abchand-Naharmau Highlands* :
- (a) The Rangir Hills.
- (b) The Naharmau Plateau.
- (c) The Jamunia-Chikhali Hills.

VII. *The Sagar-Jaisinagar Highlands* :
- (a) The Sagar Hills.
- (b) The Dhana Plateau.
- (c) The Jaisinagar Upland.

VIII. The Dhasan Basin.

IX. *The Rahatgarh-Malthone Range* :
- (a) The Piprasari-Malthone Hills.
- (b) The Pithoria Hills.
- (c) The Rahatgarh Hills.

X. *The Badar-Bina Doab* :
- (a) The Basahari Plateau.
- (b) The Parsari Basin.
- (c) The Betwa Basin.
- (d) The Narain Basin.
- (e) The 'Jhilla'.

The notable geographical peculiarities of each of the regions and sub-regions have been discussed in this paper in some details.

64. The geomorphology of the peninsular India.

R. P. SINGH, Patna.

The face of the Peninsular India has been carved out of its architectural plans of the past in relation to the grinding action of the dynamic wheels of denudational cycles. Its morphology even in its bare outline suggests polygenetic and complex phenomenon. The vertebrae of its ancient mountains like Aravalli, Western Ghats, Eastern Ghats, Satpura, spread almost engirdling the jutting landmass of the sub-continent. The cuddapah and the Vindhyan form unconformity. The sinking Permian trough recorded a chapter of sedimentation. Erosion and uplift explain its morphology. Minor inroads of seas explain the scenery in the coastal areas, and Bagh and Lameta beds.

The Rajmahal and Deccan lavas constitute significant chapter of volcanic emission and explain the scenery of their respective areas in relation to the development of denudational cycle which was augmented by Tertiary epeirogenetic reactions. The present landscape is clearly understood when the chapters of Tertiary events are constructed. The history of the Peninsular landscape consists of several chapters involving denudation, and deposition; folding, uplift, warping tilting, tearing and rifting; widespread resurrection and volcanic emission.

The author has suggested a scheme of landscape studies basing upon the three primary elements of landscape- structure process and stage.

The denudational cycles peneplaining its landscape have been treated in relation to the Peninsular parentage with Super-continent of Gondwanaland and Asia.

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65. Changes in the drainage pattern in the middle mountainous country of Orissa.

B. N. SINHA, Kharagpur.

The mountainous region of Orissa covers about three-fourths of the area of the entire State. It is a part of the Indian Peninsula with a general slope from west to east prior to the upliftment of the Eastern Ghats and the drainage channels were "consequent" in type. Subsequent to the Lower Gondwana deposits to the south-east of Cuttack during the Permo-Carboniferous period, the region along the eastern coast of India from Chota Nagpur Plateau upto Madras underwent a tectonic uplift. The old maturely disected surface was elevated upto a height of 300 metres and almost all the major rivers of Orissa could maintain their west-east courses as they have cut through the 300 metre contour line.

This deeply eroded plateau along the rejuvenated long profile also underwent two other upliftments which elevated the older surface to 600 and 900 metres in two stages. This resulted in a sharp watershed in the heart of Orissa which beheaded many of the rivers from their head waters except the Mahanadi and Brahmani which could maintain their original west-east flow.

The beheaded rivers were the Budhabalanga, Subarnarekha, Rushikulya, the Vamsadhara, and the Nagavali. The tributaries like the Koel, the Ib and the Tel came into existence on the western slopes of the Eastern Ghats with S.W.-N.E. or from N.E.-S.W. courses which captured the head waters.

It appears that the upliftment of the Eastern Ghats was completed in three successive stages or there was sufficiently longer interval between the last two upliftments.

This has been suggested by taking cross sections along the interfluves of the major rivers and at right angles to the present drainage channels. All the cross sections reveal the well developed accordant summit levels at 900, 600 and 300 metres. The beheading of the rivers can also be linked up with not only the elevations of their beheading but also with the stages of upliftment.

A study of the mouths suggests their abnormally big sizes, compared to their present catchment areas. If the main streams of the beheaded rivers are hypothetically projected in their upper reaches they roughly coincide with the general trend of the drainage pattern beyond the western slopes of the Eastern Ghats.

Further work is essential for the final conclusion of the supposition.

66. Rajmahal hills—a type study in relief and dissection index.

ANNAPURNA PRASAD MISRA, Varanasi.

The paper seeks to discuss the application of Dovnir's method of determining the Dissection Index to a part of Rajmahal Hills. The author's conclusions do not correspond with those arrived at by Dovnir.

According to Dovnir the Dissection Index is highest where the absolute and relative reliefs are medium, the Dissection Index is high in the areas of minimum absolute and relative reliefs; the Dissection Index is at its minimum when absolute relief is highest and the relative relief is medium.

The author's findings reveal that the higher hilly tracts possess greater relative relief and high Dissection Index. The uplands with moderate elevations possess moderate amount of relative relief and medium Dissection Index. In the plain area the relative relief is less and the Dissection Index is low.

The present author, therefore, is of the opinion that Dovnir's conclusion, based on observations made in a smaller area on the basis of a new method adopted for the purpose, cannot be generalized. They do not hold true for terrains of all descriptions.

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67. Movement of ground water in Meerut district, Uttar Pradesh.

R. N. MATHUR, Varanasi.

The district of Meerut covers 2,300 square miles of the Upper Ganga Doab of Uttar Pradesh. The rate of movement of ground water in the district has been found to be about 50 feet per year. The present paper records mainly the results of an investigation undertaken to study the direction of movement of ground water.

The actual direction of ground-water movement is from north to south, that is, in the direction of surface drainage, while the maximum water table gradients generally show an east-west trend—from the ground-water ridges, underlying the main canals, towards the ground-water valleys, underlying the main streams of the district. The canals courses generally run along the higher ground, that is, along the surface drainage divides between the adjacent streams. The occurrence of the ground-water ridges and the ground-water valleys actually reflects the influence of the surface relief features. The possibility of any ground-water movement from the ground-water ridges towards the corresponding adjoining ground-water valleys is definitely ruled out on an examination of the question of influent seepage from the canals.

68. Hydrography of Kolleru lake.

V. VIDYANATH, Hyderabad.

Hydrographical studies of coastal and inland lakes in India have been sadly neglected. The present paper attempts such a study of Kolleru Lake in the coastal area of Andhra Pradesh. The lake is connected with the Bay of Bengal by a smaller stream Upputeru. The lake originated as the natural remnants of a lagoon between the deltas of Godavary and Kistna rivers. It is also probable that the lake originated as a delta-flank depression as a response to the isostatic disturbance created by the sedimentation in the active deltas.

The catchment area of the lake is about 2,200 square miles while the annual yield of water is about 62,548 million cubic feet computed from Strange's Table of Runoff. Seasonal variation in the river regimes has a corresponding variation in the inward discharge and the waterlevel of the lake. The peak flow into the lake is about one lakh cusecs. The maximum depth about −3 ft. and the miximum height is about +10 ft, where the area of the lake reaches 345 square miles. A part of the Yerrakalva's discharge falls into the lower reaches of the Upputeru raising its level higher than that of the lake, and thus, retarding the discharging activity of Upputeru. Some suggestions to control the water level of the lake have been put forward based on the hydrographic features. The diversion of stream flows into Krishna and Godavary rivers should be explored.

69. Geomorphic analysis of upper Ganga-Yamuna Doab.

A. B. MUKHERJI, Hyderabad.

Geomorphological analysis of the Upper Doab reveals two broad geomorphic units; the Recent Floodplains of Ganga and Yamuna Rivers, and the Pleistocene Terrace wedged between them. The sharp contrasts between the geomorphic characteristics of the two units are expressed by the sub-parallel and dendritic drainage, and incised channel patterns on the latter surface; and the Yazoo drainage and braiding channel patterns on the former; the braiding being due to the excessive bedload of easily erodible loose sand.

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Identification of the interfluvial upland as a Pleistocene, adluvial depositional terrace is based on the following facts : topographic conjunction of the Indo-Gangetic Divide as the valley wall and the Terrace; horizontally stratified, thick, alluvial deposits; presence of lenticular, gravelly sand pockets in the subsurface layers, and that of clay on the surface indicating a grading of coarser to finer materials as a result of alluvial deposition; reddish colour of its sediments as an evidence of exposure to air, leaching, and oxidation in the pre-Recent period. Epeirogenic movement due to continuous isostatic activity transformed the Pleistocene Flood-plain into a Pleistocene Terrace, and tilted it toward the east; as evidenced by the eastward slope and incised channel patterns.

The medium drainage texture of the Terrace is due to its slight, initial relief, and permeable surface materials; while the fixation of the channels by resistant materials of Pleistocene outcrops and clay plug fillings of abandoned meanders, has resulted in their conspicuous deformities. Shallow fault controlled deformities are suggested by the recurrent patterns of right-angular confluences of streams.

The principal contribution of the paper is the identification of the interfluvial upland as a Pleistocene, alluvial, depositional terrace.

(ii) Climatology

70. An analysis of weather types of rainy season in U.P. A study in Bio-climatology.

R. N. TIKKHA and INDRA PAL, Agra.

A detailed study of the weather types of U.P. has been made from the point of human comfort on a quantitative basis. For this purpose Nicholas' method of classification has been modified in the light of scientific experiments carried out in the John B. Pierce Laboratory of Hygiene, Neewhaven, U.S.A.

Temperature, Relative Humidity, Wind and Sunshine have been studied at 8-30 A.M. and at 5-00 P.M. in the rainy season for a period of ten years. The average of data has not been taken because extreme but important weather types are lost in this process of average taking. This, therefore, needed about 37,500 readings of these elements.

As expected, oppressive weather types do not occur at Mussoorie which represents northern hilly part of U.P. Mornings and evenings at Mussoorie are comfortable.

In the plains comparatively very few weather types occur in the mornings than in the evenings. Though weather types are usually very uncomfortable, evenings of course more.

East U.P. has a higher frequency of oppressive weather types than the West. In the evenings oppressive weather types, however, spread through U.P. plains but highly oppressive weather types are more frequent in East than in the West.

71. Analysis of the Rainfall Regimes in India during the period of 180 days beginning from the 1st May.

K. RAMAMURTHY, Poona.

In this paper an analysis of the rainfall data for 50 selected stations in India for 50 years during a period of 180 days, consisting of 58 five-day periods or pentals beginning from the 1st May, has been made using the medium as the statistic after Crowe and Savur.

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It has been observed that along the west coast of India, the duration of the monsoon season steadily diminishes northwards, but the rain amounts increases from Thiruvanathapuram (Trivandrum) to Marmagoa and thereafter decrease rapidly. The bursting of the monsoon is most significant at Bombay.

The poor rains of Rajasthan are at a maximum in the pental July 20 to 24. Srinagar has an even spread of rain in all the pentals though the amounts are very small. In the Punjab the main maximum occurs in July 20 to August 3, whereas in the middle Ganga basin it occurs in August 4 to 8 in the south and 9 to 13 in the north. There is a tendency of the upper quartiles increasing towards the end of the season, pointing to the likelihood of heavy shows in some years. At Jalpaiguri very heavy rains occur from June 20 to July 9, when the median is greater than 9 cms. in each pental.

On the northern part of the east coast the monsoon rains show a very great variability towards the end of the season and in the southern part of the coast the real rains begin after October 12th. At Pamban there is practically no rain at all up to October 17th.

In Central India the rainy season extends from June 20 to September 27. In the northern part of the peninsular interior the monsoon rains are divisible into two parts marked by a pronounced minimum in between. The hot weather showers increase in the Peninsula southwards, where in the interior the later part of the monsoon has heavier rains.

72. Climates of the Mysore State

A. R. SUBRAMANIAM and V. P. SUBRAHMANYAM, Waltair.

The climatological features of the new Mysore State in Peninsular India are discussed. An attempt has been made to study the climatic types of the Mysore State according to the well-recognised and widely-accepted Scheme of Classification of Thornthwaite.

The map of climatic types of the State according to the moisture regime shows a progressive gradation of climates from arid in the central portion to perhumid on the West Coast. These several climates are seen to owe their existence to the Western Ghats. The wide areal extent of the arid climate seems to be a very striking feature of the map.

The climatic map based on thermal regime shows that almost the entire State has a megathermal type of climate, except in the Ghat regions around Bale Honnur and Marcara where meso-thermal zones are found. This signifies that the temperature efficiency of the entire region is more than adequate to support forest type of vegetation.

Five stations belonging to different climatic provinces in the State, namely—Mangalore (Perhumid), Belgaum (Humid), Bangalore (Dry Sub-humid), Mysore (Semi-arid) and Bellary (Arid), have been selected and their water-balances are graphically illustrated. Such elements of the water budget like Water Surplus, Water deficiency, Actual Evapo-transpiration as well as accumulation and utilization of soil moisture are all clearly observed from these illustrations. The graphs show not only the magnitudes of these parameters but even their durations including the times of commencement and cessation.

Work of the above nature is highly important not only in climatic studies but also in such fields as agriculture, forestry and hydrology for purposes of land reclamation and development.

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(iii) Economic Geography.

73. Well irrigation in ancient India.

K. SURENDER REDDY, Hyderabad.

The course of Civilization is intertwined and bound up with the availability of water. Take water avail, Civilization disappears, Mohanjodaro and Harappa proved that our ancients knew digging wells and irrigating lands. Perhaps the well is the first symbol of conquest of man over nature. Historically we have nothing on record to show that wells are exogenous to our Civilization.

Whether the needs of irrigation prompted the digging of wells or the marching of the armies necessitated their construction, is a debatable point. However one thing is certain. The Indus Valley Civilization stands out unique among contemporary Civilizations to the extent that it had more permeating distributive effect on all sections of the community. In Greek and Egyptian Civilization dirt and squalor co-existed with pieces of rare architecture. Hence one is forced to conclude that wells formed an evolutionary process in one of the strands of Indus Valley Civilizations.

The Persian Wheel, was also known during the vedic period from the technique adopted for drawing water in the rural sector of our country even today it appears to us that so little has changed that the vedic period continues still in our country.

In the south we have no reason to belief that prior to Indus Valley civilization wells existed. That irrigation was known in the south during early times, is beyond doubt. But it is not possible to link up early irrigation with well sinking perhaps the cultural and political contacts between the north and south might have given birth to wells in the south. Philology lends little support to this theory, unless it be that the Indus Valley civilization itself was Dravidian in its Origin.

74. Broach, the declining river port of western India.

A. T. DESAI, Ahmedabad.

The paper attempts to bring out the development and importance of Broach as an inland river port located on the river Narmada. In the pre-steam navigation age the port was more accessible from the inland producing areas and the market of consumption. In the absence of railways, sailing vessels were the most economic means of transport and Broach was one of the few important centres of trade that served a vast area of Gujarat. A favourable inland location having greater accessibility, a rich hinterland and a very extensive foreland of Arab Countries, Indian Sea Coast and even the Far East and European nations were the factors responsible for early development of the port. Added to these advantages was the deep and capacious estuary of the river Narmada which has been protected by the occurrence of few islands in the estuary.

The port, however, has been declining for the last few decades not only because of better land transport by rails and roads but also due to competition from steamships which are more efficient, economic and secure and for which Broach is not suitable. The port nevertheless can be of great help for the coastal trade of Gujarat within a limited area.

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75. Gola—a decadent small river mart.

KASHI NATH SINGH, Varanasi.

The present study deals with Gola (26°26'N. lat. and 83°22'E. long.) a small market town (4157), 33 miles south-south-west of Gorakhpur, in the Saryupar Plain, U.P., India, now on the bank of the Ghaghara and formerly on the Kuana. The prosperity of the town has intermittently waxed and waned, almost with a mark of regularity, with the caprices of the Ghaghara.

Village Madri, situated on an eminent bluff along the navigable Kuana, was selected by the Raja of Gopalpur as the site of a market town in the early part of the last century and was named Gola. The Kuana made a confluence with the Ghaghara just a few furlongs down the site. With such locational advantages and the benevolent patronage of the Raja, the town soon developed into an important entrepôt of the region. The growth of the town, however, was marred in the 1840's when the Ghaghara usurped the lower channel of the Kuana and thus the traffic bound for Gola diverted to Shahpur, the new confluence site upstream. About 1855 the Ghaghara 'reinforced the Kuana with its channels and the town could as a grain emporium compete with Barhaj.' This channel ceased to flow, however, by 1872, and the town looked again, 'poor and squalid enough'. But subsequently the Kuana again increased in volume about 1879 and the 'prosperity of Gola revived.' Eventually, however, the Ghaghara itself adopted a more northerly course, usurping the Kuana at Shahpur, and began to flow by the town. As such, the town became a port of call for the streamers along the Ghaghara, but this through traffic could not supplement the loss rendered by the truncation of the Kuana. This was the first stage of the decadence of the town, while the most fatal blow was struck with the divergence of the river traffic to the railway and the consequent rise of alternate centres like Shahjanwa, Dohrighat, and Barhaj, placing Gola in a marginal position in regard to its umland.

76. Industrial regions of Kumaon.

Y. D. PANDE, Naini Tal.

Industrially Kumaon is under-developed; even her cottage industries are at their lowest ebb in most of the cases. Excepting five units of Naini Tal Tarai and Bhabar, there are no large scale concerns in the hilly tract of Kumaon.

After discussing briefly the natural setting, system of industries of Kumaon has been discussed. Kumaon has been divided into three industrial regions. (1) The most important cottage industry of the northern Bhotia region is that of woollens, which has become part and parcel of Bhotia's life. (2) Important industries of central region are that of wool, leather, forests, bee-keeping, ringals, wood-works, tea, hemp cloth weaving, etc. (3) Industries of Tarai and Bhabar are more akin to that of Ganga plains of U. P. Five large scale concerns are located in this region, of which three are sugar mills. Important small scale and cottage industries are that of catchu making, dairying, wood-sawing, furniture, mat-making, basket making, ban, cloth printing, gur making, etc.

Generally speaking, poor returns from agriculture as well as from industries has resulted in grinding poverty and an encircling gloom of distress and desperation. Since there are potentialities of developing certain profitable industries, the battle of poverty in Kumaon is to be fought on industrial front and that too immediately before it acquires gargantuan proportions.

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77. Regional Crop Patterns of India.

SHYAM S. BHATIA, Delhi.

This paper is concerned with the regionalization and discussion of the crop patterns of India. For each district of India, the crop area under selected crops is individually related to the corresponding crop areas in the entire country, taking the crop area as a fraction of the sown area. A comparison of the area under a given crop as fraction of the sown area in a component areal unit to the corresponding value in the whole country forms the basis of determining the degree of concentration of the given crop. The regional variations in the degree of concentration of different crops are mapped and the resulting patterns of distribution are analysed.

78. India's river valley projects.

R. C. SHARMA, Allahabad.

At this juncture when our economy is at 'take off stage' of National Planning and when the nation's population is increasing rapidly at unprecedented scale, the survey of these River Valley Projects is of vital importance. Since the inception of National Planning Committee and the institution of Planning Commission, the past experiences of these valley projects are rather discouraging, as almost each and every project is beset with one or more difficulties and mishaps, some have been planned so ambitiously that the proverb 'cart before the horse' has become true, some have become too costly adventures, some have become the bone of contention and border disputes, and most of them become the prey to the evil of 'delay'. The present study aiming to investigate the geographical problems concerning the projects and of their commanding area is most timely and of some value to the planners of the nation and the geographers of the country.

In the present context it will not be possible and proper to survey all the schemes planned and executed by the central and state Governments by spending a huge sum. So this will mainly focus light on more important projects i.e. D.V.C., Hira kud, Kosi, Rihand, Bhakra, Nangal, Rajasthan canal, Chambal, Koyna, Nagarjunasagar, Tungabhadra and Mettur etc. With respect to the locational pattern of the River Valley Projects, the whole country has been divided into four regions—the Chhota Nagpur Plateau region, the Plateau division of U.P. and Madhya Pradesh, the Umland of Delhi and Punjab region and the Peninsular India. And in these regional domains the study has been made of the individual project and of their salient features and the progress through the 1st and the 2nd Five Plans. In the end, it has been realized that though these multi-millions ventures were launched to shape future of Indian economy and to raise the standard of living of the masses but in their execution many evils crept in, which have stained and polluted the wholesome atmosphere.

79. Small scale cottage industry in Kathmandu valley.

KRISHNA DEO PRASAD SINGH, Varanasi.

This submontane valley of Nepal, nestling on the lap of Himalayas, has its economy practically static since generations. Shut out to and from outside world till 1951, it was deprived of all the amenities of a civilised existence. Practically speaking there is no large-scale industry.

At present, Blacksmithy, Wood-working, Brick and Tile making, Wool carding and weaving, Textile, Pottery, Metal and leather works are the only industries

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flourishing on small scale. The valley is still at its primitive stage of iron utilisation. There is no mineral wealth. Some constructional materials like iron scraps are imported. The valley is well known for its traditional wood-carvings. This art has flourished, since generations, and has produced its own style of figure and relief. However, today, the scarcity of workable quality wood is being felt badly, as the indigenous forest wealth has been over consumed. Brick and tile is also one of the flourishing industries. But due to shortages of fuel the number of kilns are meagre to meet the increasing demand of bricks. Woollen products like 'Pashmina', Shawls, mufflers and rugs of the valley are renowned for their quality, even in foreign markets. But it is still an indoor activity. Till the last century, hand made cloth was a family affair. Cotton was imported from India. Now it has almost declined and the textile goods are the largest single item of import. The finest pottery of Nepal is made here. This is another traditional art. Though, these are other activities carried in the valley, these are insignificant.

The economic prosperity of the valley is clogged due to the inadequacy of capital, absence of economic environment, lack of transport and communication facilities, illiteracy and social problems. If measures are taken to eleminate these drawbacks, the prosperity is near at hand.

80. The nature and flow of bus traffic in Uttar Pradesh.

RAM BRIKSH SINGH, Varanasi.

The major portion of intercity passenger traffic is handled by roads. The road pattern of U.P. is fork-shaped in the Doab, interwoven by transverse and oblique roads, rectangular in the Lower Ganga Par Plain, tentancle-shaped in the inaccessible region, the Himalayan west, Tarai belt southern upland and Upper Ganga Par Plain and rib-pattern in Saryu Par Plain.

Bus traffic flow has the following features of density and direction.

1. There are several regional centres serving as focal points, which naturally gravitate, most of the traffic towards them. Significant among them are Delhi (outside), Meerut, Agra, Mathura, Aligarh, Kanpur, Lucknow, Bareilly, Moradabad, Azamgarh, Allahabad, Varanasi, Gorakhpur and Basti.

2. Because of the broad expanse of the State and short haul nature of the bus transport distinct traffic regions have emerged. These are (i) The Ganga-Yamuna Doab West, (ii) The Upper Ganga Par Plain West, (iii) The Upper Ganga Par Plain East, (iv) The Central, (v) The Eastern, (vi) The Saryu Par Plain or North Eastern, (vii) The Himalayan West, (viii) The southern Upland. The vast extent of U.P. with its diversified relief features, the degree of rail facilities available, the different types of economic activities in relation to regional focies their interrelation together with the density and distribution of population explain their traffic flow characteristics.

The general direction of bus traffic flow is parallel to the river Jamuna, Ganga and Ghaghra. Due to lack of bridges over the rivers North-South movement is broken.

81. Suratgarh farm—a Geographical Appraisal.

S. L. KAYASTHA, Varanasi.

Suratgarh (29°20'N. and 73°54'E.) lies on the Jodhpur-Bikaner-Bhatinda railway line, at an elevation of 600' on the left bank of R. Ghaggar. Headquarter of a tahsil in Ganganagar district, it is a small dusty town on the fringe of desert.

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Suratgarh first attracted wide notice on account of the siting of Central Mechanized Farm.

Work on the Farm started in 1956 with the help of farm machinery received from the Soviet Union. The Thirty Thousand Acre Farm comprised of unpromising land covered with sand-dunes and xerophytic vegetation. Here, rainfall is deficient, winter frosts are not uncommon, and excessive heat and sand storms menace summer. Soils suffer from lack of moisture and alklanity. Water-table is deep and sub-soil water is often brackish. By 1959-60, more than 2/3 of the area had been reclaimed and most of it brought under cultivation. This was made possible by the use of farm machines. Yields are average but are maintaining an upward trend. Farm economy is well organised.

The Farm performs the function of multiplication of improved seeds and proposes to breed pedigree cattle and supply quality nurslings. The propagation of pedigree seeds, pedigree cattle and pedigree plants will transform the face of land and increase agricultural production. The Farm is a positive step towards augmenting food-supply in the deficit zone and is a model of mechanized and scientific farming.

82. Rice cultivation in Kolleru Lake.

V. VIDYANATH, Hyderabad.

Rice cultivation in the bed of Kolleru Lake, Andhra Pradesh is an interesting study of cultural adaptation to hydrographical features of the lake. The present paper analyzes the techniques of cultivation of rice in the lake. It was found that there is a significant correlation between the seasonal variation of the waterlevel of the lake and the availability of the exposed land for cultivation. Irrigation is done by lifting water from the lake by engines. During the first crop season fishing is substitutes cultivation activities. *Nallarlu, Akkuleru,* and *Konamani* are the important varieties grown in the lake. Different varities are grown in the two crop seasons. The significant difference between the first and the second crop season techniques is bunding in the latter. Transport of paddy is done on boats in the first crop season while in the second season by bullock carts. This change in transport is due to the alternating wet and dry conditions of the lake. Most of the other techniques involved in the cultivation of rice in the lake are similar to those of the surrounding areas. A systematic and detailed analysis of these are given in the paper.

83. Coal industry in Chota Nagpur highlands.

RAMESHWAR PRASAD SINHA, Bhagalpur.

The occurrence of coal in Chota Nagpur Highlands is determined by the distribution, nature and structure of its geological formations of Gondwana-makings. It lies in the Damodar and the Auranga basins in an east-west direction and in a few isolated areas of Hazaribagh, Rajmahal and Daltanganj. The Indian Coalfields Committee 1946 estimated the reserves of workable coal in Chota Nagpur at 13146 million tons i.e. 81 per cent of India's total reserves of 16484 million tons.

Coal-mining in India was started in 1774 in Raniganj area, but its earliest scientific exploration was launched in 1845. During the First Great World War, out of India's total output of 21 million tons, Chota Nagpur shared 16·5 million tons, which had gone down in the inter wars periods. The Second Great World War gave a stimulus to its produces and the production of the region rose progressively to 15·9 million tons in 1942 and 16·50 million tons in 1945.

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The planned development in Coal Industry was undertaken only after Independence during the pre-plan and best plan periods. The successful completion of the production reached 20 and 28 million tons respectively. This output will have to be further increased to meet the growing demands of the developing economy of the third and the subsequent plans.

India's industrial economy is based on coal of Chota Nagpur region. The development of coking coal of all grades and qualities encouraged the establishment of TISCO, ISCON, MISCO; Rourkela, Bhillai, Durgapur, proposed Bokaro, and a few future steel plants of the country. It provides fuel to Sindri, Bokaro, Chandrapura, proposed Patratu Karanpura and other growing thermal projects, railway engines, local and nearby factories, domestic works, and infinite variety of plants manufacturing by-products.

Out of 845 coal mines in India Chota Nagpur has 535 of which 250 are mechanically worked and 285 manually. The average daily number of persons employed in all the coal mines in India was 3,52,800 out of whome 1,82,500 persons were employed in the coal mines of the region in 1960-61.

84. Crop pattern in the Sub-Himalayan Region of Eastern Uttar Pradesh.

MOHD. NASEER KHAN, Allahabad.

In this belt of Terai-alluvial complex which presents a fertile field of geographical study; topography and climate, soil and vegetation with their varieties and vicissitudes have induced typical human response. The region shows a wide range of rainfall between north and south and the production in terms of cereals is not impressive. Dominating features of agricultural situation in the region are three fold : the or low productivity of most of the region's land surface, the failure of the region's agriculture to meet in full nutritional requirements of the population, and thirdly the adverse physical forces in the form of pests and variability of rainfall leading to soil erosion and floods.

The points emerging from the study are as under :

(1) The region is not over-generously endowed by nature with good agricultural land and is faced with the prospects of rapidly expanding population; maximum output in terms of food value is essential.

(2) Except in the case of rice, it is difficult to establish any close co-relation between physical environment and land-use and sometimes crop pattern.

It would seem that a closer adjustment between the physical environment and improved farming practices are essential if the region is to attain its maximum food output.

85. Transportation of coal from West Bengal-Bihar coalfields.

JAGDISH SINGH, Varanasi.

West Bengal-Bihar coalfields account for 90 per cent of the country's annual output. The transportation of this coal for distribution all over the country is of utmost importance because any falling back results in severe power crisis.

On the basis of the distributional pattern of this coal the country can be divided in six regions. (1) the western and Northwestern region. (2) The Down country region. (3) Bombay-Madhya Bharat-Saurashtra region. (4) Andhra-Orissa region. (5) The Central region and (6) The southern region. Of these the first two regions receiving 8·2 and 7·1 million tons respectively are the most important and the last three are comparatively insignificant.

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Distance from these coalfields, the amount of other powers mainly hydro-electricity available, presence or absence of local coal, nature of industries and level of industrialisation, facilities of getting coal from these fields by other means, and the level of demand of coal for domestic purposes explain these differences.

The railways handle almost all the coal traffic of these fields. The Grand Chord line bears the heaviest traffic going towards the first region. The limited capacity of Mughal Sarai yard is the main bottle-neck. This along with the shortage of wagons has created a coal crisis in the first region.

The following measures are suggested to ensure efficient transport of growing coal traffic from these fields in future.

1. Construction of a Trans Ganga Chord by converting the metre gauge trunk route via Gonda, Gorakhpur and Chapra upto Barauni into broad gauge and linking it to Sitapur.
2. Doubling and improving the Burwadih loop and the Garhwa Road Churk link under construction.
3. Encouraging road transport from these fields upto Varanasi by liberalising the permit rules and speeding up the construction of proposed road bridge over the Son at Delhi.
4. Diverting the coal for coastal shipping from Raniganj to water transport in Damodar upto Calcutta by creating suitable facilities.

(iv) Human Geography.

86. Pattern of Growth of India's Cities of over 100,000 in 1951, during 1901—51.

AMRIT LAL, Chandigarh.

This paper analyses regional variations in the population growth in India's 71 urban places, classified as cities in 1951, since 1901 and compares the growth rates of manufacturing and non-manufacturing cities during 1931-51.

The population of these urban places has grown faster than India's urban population, and most of this increase occurred during 1931-51, when the growth rate was 107 per cent against 37 per cent during 1901-31. The number of 'Cities' also multiplied remarkably during 1931-51.

During 1901-11, the north, central and western zones had most of the places with a declining or stationary population, whereas in the south and east zones most places kept growing. During 1911-21, the places in the west and central zones grew faster than those in other zones. During 1921-31, the growth was considerable for all urban places, although fewer places in the north had high growth rates. During 1931-51, a period of accelerated and vigourous growth, more places had higher growth rates than ever before; 26 places grew at rates of 106-215 per cent. The central, western and eastern zones had the largest share of such cities.

An analysis of growth rates (1931-51) of manufacturing and non-manufacturing cities indicates that (a) the most potent factor for growth is a high relative employment in manufacturing, following by public administration, transport, professional services, and retail trade, and (b) among manufacturing cities, specialization in transport and public administration are contributing factors.

87. Growth and Trends in Population of the Tarai region of U.P.

L. R. SINGH, Allahabad.

The scattered ruins and historical records provide ample testimony that the Tarai Region of U.P. is a region of ancient settlement. During the Buddhist

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period it was a flourishing land having comparatively large population. However, with the fall of the Gupta Dynasty, and, especially after Harshavardhan of Kanauj, a sordid political confusion took fast grip of the country, and, perhaps, an adverse climatic change added fuel to flame and Tarai shrunk in prosperity. Progressive decay set in : cities desolated, farms and fields deserted, the region relapsed in the "dark jungle" by 1100 A.D. According to Muslim historians it was hither and thither interspersed with patches of grazing and cultivation and a few aboriginal tribes, like the Tharus, the Bhoksas and the Bhars occupied the land.

However, its destiny changed with the rise of local feudalism under the Muslims and during Akbar's times it was under the Mughal sway as a frontier or "marginal" tract. During later Mughals and under the Nawabs of Oudh, it became a much settled country with an approximate population of 2 millions.

During early British period it once more declined. But later on, some enthusiasts like Sir Ramsay took lively interest in the Tarai development by encouraging the people to settle down there. Nevertheless, Tarai remained for long a resort of famine striken and the like and gained in population as a marginal land at a cost of Ganga plains. But the ultimate conquest of Tarai began in the post-independence are for settling the uprooted, cultivators from Pakistan, providing employment to the demolished soldiers and the unemployed and for increasing food production to feed the hungry millions. As a result the 1951 census recorded a population of nearly 2·5 millions in this region.

The recent trend of population has been upward, but the settlement of Tarai in the manner of the Ganga Plains seems to be problematic, for the geographical conditions of land will sanction no such wide latitudes.

88. Educational institutions of Lucknow—A study in Social Geography.

M. N. Nigam, Kanpur.

The educational institutions of Lucknow started as 'Madrasahs' during the Nawabi-days. The present system of education began during the British-period. At present Lucknow has almost all types of educational facilities beginning from the primary upto research. Higher education is imparted in Arts, Science, Law, Commerce, Education and Medicine faculties. In addition there are several technical and professional institutions also in the city. For the intellectual class, there are 28 different types of associations and societies and several big libaries.

There are 152 primary schools, 8 junior high schools, 4 high schools, 29 Inter colleges, 7 degree colleges, and more than 20 technical and professional institutions in this city. The enrolment in primary schools varies from 52 to 393; in secondary schools from 150 to 1760; while in colleges it is from 360 to 830. The city has good facilities for female education. Most of these institutions are privately managed.

The establishment and development of these institutions have caused a large number of people to come to the city for settling permanently and have thus helped in the expansion of the city in area and the growth of multifarious activities.

It is suggested that Higher Secondary schools and technical institutions should be shifted on the periphery, i.e. away from the city heart. The University is rightly located. The areas of high density of population need several new primary schools. The primary and girl's institutions may remain where they are, but some improvement has been suggested for them. Thus replanning of these institutions is necessary, both for reducing the pressure of population in the city proper, and for providing better environment to both, teacher and the taught.

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89. Origin, evolution and dispersal of Bhawanti House type in Andhra Pradesh.

A. B. MUKHERJI, Hyderabad.

Bhawanti house type is dominant and has a continuous distribution in Telengana and Andhra regions; while in other regions of Deccan it has a disjunct distribution and a recessive existence. Neither the word *bhawanti* nor the associated house type is known outside the Deccan. Its morphology is essentially square; and its structure comprised of four dwelling units (*chaturshala*), surrounding the central hall, completely closed by the projecting roofs of the rooms, except for a small, square opening in the center. Just below the opening is a small, square pit in the central hall. The roof consists of four gables forming a pyramidal shape.

Linguistic evidences based on the derivation of *bhawanti* and *chaturshala bhawanti* from the Sanskrit words *sah bhawanti;* and the current usage of Dravidian words *nalgupura* and *nalgusutra* without any reference to the architectural form or structure points definitely to an Aryan origin of the form of the house. Bhawanti form is therefore, not indigenous to Telengana or Andhra regions. The use of the central hall as a place of family reunion and of the pit as a marriage mandap where the rites can be witnessed by the heavenly bodies is clearly a derivation from the central, square courtyard of the Aryan house with the same functions.

The pyramidal roof is an adaptation to heavy, short-duration rainfall, and hence must have originated in the coastal Andhra region, and cannot be an indigenous evolution or an independent origin in Telengana. Its dominance and continuous distribution in Telengana is due to, both, a transference of culture trait along with the migration of Telugu people including Reddis from the Andhra regions and their settling in Telengana; as well as, to the migration of a culture idea without involving any migration of a people.

The morphology of the bhawanti and its central hall is Aryan in origin while the roof is Dravidian.

90. The origin and racial affinities of the Bhils.

RAJ KUMAR NIGAM, Kanpur.

Regarding the origin of the Bhils there are many theories and innumerable historical and anthropological views are expressed by the various authors namely Manu, Webers, Commentator Mahendra, Enthoven, Gunadhya, in the Puranic and Mahabharat accounts, in Bhairawi's poem Kiratarjuniyam, Valmiki's Ramayan, Kadambari of Ban Bhatt, Abul Fazal in the famous Ain-i-Akbari, Lt. Col. Tod, and many others from time to time. But finally as Dr. Majumdar puts it, it seems, he says; 'Bhil is a generic name given to the various older and simpler peoples of the land by other invading people. The same is the case with the Rajputs who do not represent a specially homogenous type, while the racial status of the Bhil on anthropometric grounds is uncertain as diversified opinions are expressed by Prof. B. S. Guha, Herbert Risley, Crooks, Mahalanobis, Stephen Fuchus, E. W. R. Macfarlane, P. G. Shah, T. N. Dave, Dr. T. B. Naik, Dr. D. N. Majumdar and Smt. Uma Bose, and the general conclusion that one is tempted to reach is that the Bhil is a term used to include all those people who live by chase; i.e. those who use bow and arrow—the term 'bhil' is said to have been derived from the Tamil word 'Bhilawar' or a bow-man. But the more we analyze the data says Majumdar, "The more it transpires that the Bhils are racially more distant from the so-called pre-Dravidian groups while they approach nearer to the higher castes. According to Rev. C. Thompson 'The Bhils form a completed arch resting upon two distinct pillars one representing the aborigines of India and the other Aryan. This view seems to be more balanced on the basis of language.

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91. On the Social and Cultural aspects of 'Baidipur Sasan', Mayurbhanj District, Orissa.

B. C. ACHARYA, Cuttack.

Baidipur Sasan (21°·46′ :86°·42′) is situated on the eastern slopes of a laterite exposure. The land is fertile to the east and rocky to the west and south. Sri Bira Baidyanath Bhanj Deo, one of the rulers of the former Mayurbhanj State was the founder of this village. He selected twelve good Brahmins from outside the state and gave them facilities to settle permanently in this village. A few Adibasis used to live in this area during that time. They helped these new comers as labourers in constructing their houses and ploughing the lands for them. Thus it grew out to be the nucleus of all the activities of the area.

The village is linear in pattern having two rows of houses, with a road in between them. It has got its temple and tank on one side, school and weekly market place on the other. Families have increased in number, lands and houses are partitioned, so new problems have crept in. People have gone outside the village to work in towns and factories. Road communication has improved with other areas during the last two five year plans. The village economy is under transformation.

Village festivals and customs still play a great part in their day to day life. The villagers and also the Adibasis have become politically conscious.

An attempt has been made in this paper to describe the social and cultural aspects of the village, keeping a view with the changing economy of the society.

92. Fire Incidence and Tile Industry in the State of Orissa.

M. M. HASAN, Cuttack.

The State of Orissa is a typical tropical country. As a result the mean annual and maxm. temperature found here is 80 and 90 degrees respectively. The rainfall over the area is equally high—about 60 inches.

These geographical factors have combined to help produce large quantities of rice all over the State. On account of the fact that the region is warm for most of the 12 months, and further, cheap and abundant availability of rice straw has a novel use of it in house roofs which keeps the dwellings cool. Hence a very large percentage of kutcha and pucca houses constructed are thatched with straw.

But straw is highly inflammable. The planning of houses are also defective. The roofs and eves are low. The use of naked flames like "Dhibri", "Dipas", and cooking at places where eves hang low are responsible for fire outbreaks.

This incidence leads to heavy loss of life and property. One of measures to check it is the expansion of Orissa Fire Service. But it is curative in nature. However, the only best preventive measure is the use of 'khapra' or tile. It is sufficiently safe against fire and commonly used in Northern India.

The Government should start tile industries at suitable points and products sold at subsidized rates.

There is one technical difficulty in manufacturing tiles from local soils as it contains a large constituent of quartz (sand). This makes tile brittle and cracks develop leading to seepage.

One of the research sections of the Central Building Research Institute, Roorkee, can solve the difficulty by evolving some formula for the necessary treatment of local soil to remove the technical difficulty.

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93. A Regional Analysis of Literacy in India.

GURDEV SINGH GOSAL, Chandigarh.

With only 16·6 per cent (1951) of her people as literate, India is still far behind many of the nations of the world in literacy. For a large number of people the ability to read and write still apparently has little purpose. The salient features of literacy in India are :—(i) Literacy is fairly high both among males (55%) and females (27%) in the urban population (of over 10 years of age, 1951); (ii) regional differences in urban literacy are rather small; (iii) not only is rural literacy much lower (24% among males and 6% among females) than urban literacy but also there are significant regional contrasts in it; (iv) the male-female differential in literacy among ruralites is far greater than in urban population and there are large regional variations in the male-female differential in rural literacy; (v) in general, there is a strong inverse correlation between literacy percentage of general population and the male-female differential in it.

In this paper the discussion on regional differences in literacy in India is based on a choropleth map made from districtwise data on literacy. Although, in general, the percentage of literacy is correlated with the degree of urbanization, there are areas, such as Orissa and Assam, which are little urbanized and yet the literacy percentage there is much higher than in most areas of India. Similarly in Kerala, which is only moderately urbanized, literacy, both among males and females, is most widely spread. In the spread of literacy in these areas the contributions of the missionaries have been very great indeed.

Interestingly, nearly all the areas of lowest literacy, particularly of the rural population, are the former native states where little attention was paid toward public welfare and education.

94. Human Habitations in the Himalayan Beas Basin.

S. L. KAYASTHA, Varanasi.

Human habitations were established in the Himalayan Beas Basin long before the Aryan infiltration. Accessibility of agricultural land is the main consideration in the establishment of human settlements. Most of the population resides in rural habitations varying in size from isolated hamlets to semi-sprinkled settlements. Valley areas have small hamlets with a common village site but the mountainous parts are area of true dispersal. Some of the highest human habitations are found there. Out of the varying conditions of valleys, low hills and mountains, have developed semi-sprinkled, sprinkled and isolated habitations. Hill villages are very picturesque. There is no plan except what factors of site dictate. Rural houses are simple and built with local materials. House types exhibit the influence of local conditions and vary in each sub-region. Daulatpur, a type study, gives a general picture of a Himalayan village.

The earlier fort-site towns have decayed and new centres have developed where advantages of nodality and access exist. The raison de etre of small urban and rurban centres is their accessibility to rural areas and their function as collecting and distributing centres. Dissection of relief and inadequate communications inhibit growth of large habitations. Scattered and small village communities do not provide the sap for the growth of large urban centres; Himalayan towns still carry strong agricultural elements. Kangra provides an example of a type study of a Himalayan town. Patterns of other urban habitations are also discussed.

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(v) Regional Geography.

95. Physical make-up of Central Rarh region.

S. P. CHATTERJEE and K. BAGCHI, Calcutta.

The Central Rarh Region corresponds to the lower Damodar Valley region of West Bengal limited by the River Hooghly on the east and a line joining Bishnupur with Durgapur and its continuation northwards to the West. The northern and the southern limits are constituted by the rivers Mor and Dwarkeswar in the north and the south respectively. The region permits of division into five main regions—the upland, marshes, the levee, the Doab and the Plains. The micro features and other characteristics have been discussed in the paper.

96. A Geographic Study of Gunung Kidul—a Problem area in Central Java.

M. HALIM KHAN, Aligarh.

1. In an island which is extremely fruitful, but does not enjoy high living standards, Gunung Kidul stands out for its exceptional poverty. Its topography, underground water resources, soils, vegetation, and hence, its level of living, are significantly different from the rest of Java. Moreover, this intensity of poverty is being accentuated by both human and physical factors. Forests are being mercilessly cut; farming land is being swallowed up by extending settlement and cemetries; the population is multiplying rapidly; erosion is common and pests and diseases are becoming increasingly serious for both human and vegetation. Constant reference to this area became a challenge to the Department of Gadjah Mada University, Jogjakarta.
2. The total area is about 1500 sq. km. with an average N-S dimension of 41 and E.W. of 46 kilometres. It is situated in the south eastern part of Central Java, in the autonomous province of Jogjakarta. The term "Gunung Kidul" literally means "Mountains of the South", and geologically it belongs to the upper strata of a succession of formations which comprise the southern mountains of Java. It includes an area known as "Gunung Sewu"—"Thousand Mountains"—but this is something of a misnomer, since nowhere do these uplands exceed 450 metres. Most of the topography has a limestone character, with bare karst in the south, and outcrops of volcanic sediments in the north and marl in the centre. It is essentially a land of hills and of dissected limestone hillocks.
3. The total population is roughly 500,000, but the distribution is far from uniform, the compactness or dispersion of settlement depending generally on soil types, physiography, and especially availability of water.
4. The type of land use which have developed are as follows : Out of the total area of 1500 sq. km., approximately 66 per cent is cultivated. But this figure should be accepted with caution, because the area is unlike other Japanese agricultural areas, and the problem of defining just what is a cultivated section is a real one.

In all our estimate is that 66% is cropped
12% is in pasture
6% is in forest

with the remainder being used for fruit trees, settlement, roads, ponds and graves, the latter occupying 16% of the total area.

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97. Afzal Garh—a Classical Example for Development under the Community project—a Geographical analysis.

SURENDRA NATH, Varanasi.

This paper in detail includes the original research work of Geographical Analysis being carried out in the area, and the effect of planning on the conditions. Geographical Analysis describes the conditions (Physical, Cultural and Landuse) prior to the Block, Conditions after opening the block and achievement by the Scheme with some suggestions to improve the planning.

Afzalgarh Block of Bijnor District furnishes an excellent spot for the study of geographical problems. The physical factors have played a great role in making this area infertile and barren. Ram Ganga and its numerous tributaries (Hill-torrents) which carry little water throughout the year but are subject to heavy floods in rainy season make the communication difficult, cause to the Soil Erosion and convert the land into marshyland. Geologically the area is also peculiar having no Terai belt between Bhabhar and Bhangar. Climate is also uncomfortable and causes to many diseases. The area was most backward in the field of Education prior to the envisage of the Block and still it is. Standard of living is humble, better than Eastern U.P. Inspite of several streams and hill torrents, the problems of scant irrigation facilities exist and no improvement is visible.

Though the Extension Services had done much for this area, yet the area is not much benefited and is still a backward one in all respects. The reason of the failure may be the negligence of the Geographical Factors in planning. The man is slave of the environment, but the environment factor is generally discarded.

After considering all these factors, in the end the author has suggested about 22 suggestions for improvement of the planning.

The present work leads to conclusion that the planning must be done after analysing the area geographically and it must be done on Block-level instead of District-level. Construction of Kalagarh Dam is most necessary. Geographical analysis of every block before starting the developments is most necessary. Planning should be done and carried out by technical persons such as Geographers, Agriculturists etc., because Geographical factors play a great role in making the area.

(vi) Land Use.

98. Changes in the pattern of arable land in Chakia Tahsil of Banaras District (U.P.).

BASANT SINGH, Varanasi.

The study relates to the changes in the pattern of arable land on Vindhyan plateau as well as Ganga plain of Chakia.

Since 1880-81 old and new fallows have almost disappeared from the area due to the pressure of ever increasing population and the rise in prices of agricultural commodities. The development of irrigational facilities have also encouraged to bring more land under the plough. The marginal lands too, have proved profitable for cultivators. The virgin lands in the open forests have also not been kept out of cultivation. From the agricultural records of 1948 it is obvious that as many as 17 new villages have been established on the Vindhyan plateau, which are producing mostly food crops.

It is striking to note that some of the very important crops like indigo and opium have disappeared and sugarcane is gradually diminishing in importance; their place is being taken by food crops. Owing to increasing irrigational facilities

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the double cropped has increased. It may be remarked here that not only the acreage under food crops but also the yields per acre have considerably increased.

99. Moradabad district Changes in Land Use.

S. L. DUGGAL, Muzaffarnagar.

The main land use categories found in this district are (a) Arable Land, (b) Groves and Orchards, (c) Waste land or banjar, (d) Land under water and (e) Land agriculturally unproductive. There is little forest and little grassland. A thousand years ago, there used to be much forest but it has been reclaimed for settlement and cultivation during the course of time.

The arable is the predominant type of land use and nearly 85% of the total area of the district falls in this category, while 1% is under groves and orchards, 5% is wasteland or banjar, 3% is under water and 6% is under settlements, roads etc. The old fallow has been totally reclaimed. The wasteland, land under water and grove land used to be more extensive formerly, but these categories of land have also been reclaimed. But the land agriculturally unproductive is increasing at a rapid rate owing to the development of settlements and means of communication.

100. Historical Evolution of Land Use in Nova Scotia.

SAVITRI G. BURMAN, Delhi.

Use of land in Nova Scotia, in its type and intensity, has been very greatly influenced by its location, in addition to the other physical attributes of the land, and the advance in technological developments. Its location as regards Europe, New England, and other population centres of Canada has influenced, both directly and indirectly, the evolution of its land use in its broad aspects as well as details, by very largely directing the history of its settlement and the origin of its population.

Because of being the centre of arena of struggle for possession of North America between England and France for a century and a half, the only settlement made was by a small group of the French, who were later turned out. Settlement in Nova Scotia in earnest began only after 1760. From those days, the land use in Nova Scotia has changed vastly, in detail, when the emphasis was on growth of grains, fibres for clothing, wild products of the woodland, and the sea. After passing through various stages of grain production, livestock production, lumbering and allied activities, it has evolved into a dairy economy, with production of fruit, vegetables, poultry and eggs on good and sub-marginal agricultural lands, abandonment of marginal agricultural lands to woodland, and new types of land use in mining and recreation lands.

101. Land use characteristics in the West Hooghly Conurbation Belt.

S. P. CHATTERJEE and K. BAGCHI, Calcutta.

The Hooghly Conurbation belt West was studied in field and the information obtained was analysed. Though conurbation is usually intended to apply for areas where a continuous series of dwellings, factories, harbours and docks, urban parks and playing fields etc., which are not separated by rural land though in many cases such urban area include enclaves of rural land which is still in agricultural

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occupation are found, there is no such thing as a typical conurbation in West Hooghly Belt. It does not consist everywhere of well integrated towns. Rather one notices a series of sprawling industrial areas tied for social purposes into administrative parcels labelled urban municipalities. The percentage of break up of land for different categories of area has been provided. An indication has been given that there is a trend for a continuous belt to evolve by incorporation of existing blanks in an unplanned manner which will worsen the existing problems of drainage, water supply, transport and congestion.

(vii) Urban Geography.

102. Karwi—a Geographical study.

NARAYAN PRASAD, Allahabad.

The present paper attempts an analysis of the evolution and morphological development of Karwi, a town in Banda district of Uttar Pradesh. Karwi, a railway station on the Manikpur-Jhansi section of the Central Railway, is located on the bank of the Paisuni, a tributary of the Jamuna. The Vindhya hills in the south are not far from here and Chitrakut, the famous place of pilgrimage is only a distance of 3½ miles. The settlement was founnded as a colony of Brahmins some 300 years ago. Since then, the colony had been under the suzerainty of the "Mahant" of the 'akhara' of Jagannath and Amrit Rao and Binaik Rao. From a village of only 6,054 souls in 1865, it has now grown into a town of more than 15,000 persons consisting mainly of low castes with few Brahmins, Rajputs and Vaishyas.

The former Karwi Notified Area included Purani Bazar, Naya Bazar and Tarahuwan consisting in 6 mohallas. Only recently the nearby settlement of Sitapur was combined with Karwi to form the present local authority named as the Chitrakut Dham Nagarpalika. The social institutions of the town include several educational institutions, a dispensary, temples and Dharmshalas. It houses several government offices and is the seat of sub-divisional administration. The industries and manufactures of the town include stone-utensils, glass and lac bangles, wooden toys and 'biri' manufactured from indigenous 'tendu' leaves. It is an important marketing centre for food-grains, oilseeds, ghee, mahua, sugar and hides and skins. The Allahabad-Banda road passes through this town.

Karwi is a growing town and has vast potentialities conditioned by active public participation and adequate government aid for its development. Electric supply, water supply, drainage and sanitation and improved roads are its immediate needs.

103. The Tributary Area of Baroda.

V. A. JANAKI and M. C. GHIA, Baroda.

The paper critically examines the nature and extent of the tributary area or the city-region of Baroda. The indices used are high school education, medical and newspaper services, transport frequencies, industrial labour, vegetables and milk supplies and the weekly market service. The nature and shape of the city region depend on the size and function of the town, the transport facilities in the region, the commercial facilities presented by the country side, the degree of economic activity of the city as compared with the neighbouring towns and cities, its political, cultural and historical associations with the region and general lay out of the country. The slow growth of urbanism and the traditional self-

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sufficiency of the village in India, together with the inadequacy of transport and lack of specialised services in towns have restricted the town's influence over the region. The city is not a dominant feature in the cultural landscape of India. However with rapid industrial development the city and its region will assume greater significance and an understanding of this town-country relationship will be necessary for regional economic planning.

104. External Transport of Cuttack City.

RABINDRANATH RAY, Cuttack.

The transport of Cuttack city may be discussed under two separate heads. These are external and internal. In this paper an attempt has been made to study the external transport of Cuttack city.

Inspite of its wonderful position at the apex of the Mahanadi delta riverine traffic is practically unimportant here due to a number of geographical factors. These are (1) the nature of the river bed and the volume of water in rivers, (2) the presence of sand bars at the river mouths, (3) presence of mangrove swamps, (4) destructive cyclones, (5) heavy floods.

Land connection of some sort existed during the Muslim and Marhatta periods. But roads were unpaved, bridges were few and journey was slow and risky. The backwardness of road connection was due to a number of geographical and political factors. Among the geographical factors are (1) the natural isolation of the district, (2) presence of innumerable rivers in the deltaic section, (3) muddy soil, (4) difficulty of getting road building metals. Among the political factors the most important is the constant neglect of Cuttack and Orissa as a whole, in periods when the province was either conquered or attached to other States.

Lots of improvement have taken place in the external communication of the city, but still more is needed. Development of external transport is suggested on the following lines (1) starting of a duplicate Howrah-Puri express and a shuttle service between Bhubaneswar and Choudwar, (2) proper paving and widening of roads connecting Cuttack with small towns and villages in the delta, making them suitable for heavy traffic movement, (3) deepening and widening of canals and making them suitable for launches and boats.

105. Evolution of Towns in the Upper Damodar Basin.

HEM PRIYA DEVI, Varanasi.

Every region records the hours of development when man develops his intimacy with it. The region may have variety of treasures over its surface and in its inner vaults but it is man's accomplishment that motivates him to change the face of the country by testing his accomplishments in relation to the potential resources of the regian concerned. The Permian-Triassic trough of the upper Damodar is one such region of great potentiality. The Damodar along with its tributaries was busy in washing the treasured wealth unnoticed and unhampered. This virgin countryside went on unwedded till the first axe of the aboriginal broke its silence. With this early phase of man's punctuation, the region started to time the different phases of developments.

Industrialisation has greater relation with the multipurpose project of the Damodar which is a very significant phase in inscribing new cultural land scape. The Damodar and its major tributaries have been dammed at convenient points

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like Tilaiya, Panchet, Maithon, Konar with urban outlook. Other towns like Bokaro Sindri, Gumia with industrial activities have been grouped in the list of towns. The future steel town of Bokaro would be a new urban dot on the Damodar Valley map.

All the new towns which have come into existence are the outcome of the damming of the Damodar along with other factors.

106. Population Growth of Jhansi.

J. P. NAGAR, Allahabad.

In the present paper attempt has been made to discuss some characteristics of the population growth of Jhansi. Although the town dates back to 1553 A.D. yet no early census records are available. In 1857 the town was one of the richest cities of central India with about 60,000 souls. In the First War of Indian Independence the British forces razed the city to the ground and slew most of its inhabitants. Several thousands left the town out of fear. After 1857 the total population was reduced to 7,000. According to Atkinson's estimate of 1881 the total population of Jhansi was 32,987 which rose to 76,126 in 1911. It recorded a decrease of 2·6% during 1911-21. It is significant to note that during 1921 the percentage increase was higher than that of any Kaval town of U.P. In 1941 for the first time the population of Jhansi exceeded one lakh mark. During 1951-60 the population of town rose by more than 33% and the city's rank became twelth amongst the towns of U.P. which was fourteenth in 1951. The universality of marriages, high proportion of married women, and unpopularity of family planning accounted for high birth rates. While lack of medical facilities and ill-sanitation, famines and other natural calamities were responsible for high death rates. Jhansi attracted a large number of immigrants due to increased employment opportunities in the wake of decaying native industries and old trade routes in the surrounding area.

107. Some recent trends in the growth of population of Allahabad.

R. L. DWIVEDI, Allahabad.

In any scheme of town planning the usefulness of population analysis needs hardly any over emphasis. The present paper attempts to discuss some of the recent trends in the growth of population of Allahabad—one of the five Kaval towns of Uttar Pradesh, India. In the present century city's population has risen by about 150% (1901—172,000, 1961—432,000). However, the growth has not been continuous. The first two decades witnessed a slow and steady decline of the population while since 1921 it has indicated a well-marked upward trend. The city, which ranked fourth among the Kaval towns in 1891 has always been fifth since 1901. It lost its rank as one of the fifteen largest cities of India in 1921. Three factors are mainly responsible for swelling of numbers. (1) Natural increase, (2) Immigation and (3) extension of municipal limits. Significantly the population has risen more through immigration than through natural increase during 1921-50. The last factor accounts for substantial increase in the 1961 population, because limits of the city were greatly extended in 1956 and again in 1959 to raise the city municipality to the status of a Corporation. (The Municipal area prior to Oct. 1, 1956 was 15·94 square miles; on Feb. 1, 1960 it stood at 24·2 sq. miles). All the three factors of growth have been fully discussed in the paper.

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108. Functional Topography of Bhagalpur.

S. P. SINGH, Varanasi.

Bhagalpur, headquarters of Bhagalpur division, Bihar, lies on the southern bank of the river Ganga (25° 15′; 87° 0′E). Bhagalpur is essentially a large urban amalgam of multinuclear character and displays various clusters tracing their origin in the ancient, medieval and modern growths with vast interstitial spaces throughout the urban landscape. A close study reveals that (1) The core of the commercial activity coincides with the new heart of the city; the Sujaganj, (2) Some new shopping parades have grown up mainly along the main roads, (3) Most of the wholesale shopping parades are located in the main commercial area, (4) The grain and meat markets show a peripheral location.

Educational institutions are scattered throughout the city but are large educational zone has developed south of the Tilha Kothi. Generally all administrative centres are located near sandis compound.

Quite naturally the Bhagalpur Railway station area has attracted the location of industrial sections of the city, both in the north and south.

Agricultural lands are found in the interstital open spaces as well as on the periphery.

Based on the functional character of different parts of the city, the area can be divided into functional regions. (1) Residential area, (2) commercial area, (3) educational area, (4) administrative area, (5) industrial-cum-residential area and (6) agricultural area.

Thus it is mainly a commercial-cum-administrative centre.

109. Demographic Structure of Visakhapatnam.

B. P. RAO, Varanasi.

Visakhapatnam, one of the six major ports of India, is located on the East coast in the middle of Calcutta and Madras. Its rapid economic and commercial growth during last fifty years has brought a distinct change in the demographic structure of the town.

Though the town was refounded in the 17th century, its growth was slow till the first decade of the present century. The town saw a very rapid growth of population during the last 80 years (585 per cent). Indeed this rapid growth was experienced after the opening of the modern harbour in 1933 and establishment of the University and other social institutions in the same decade. After the establishment of the large and small scale industries, during the last decade, the growth of population has again received a strong momentum.

The present population of the town is 207,506. The distributional pattern of population shows a distinct departure in the density in different areas of the town. In some parts of the old town the population has decreased whereas the thinly populated areas show a marked increase in density. The lack of space in some parts of the old town has created slums which inhabit 40% of its population. Likewise the livelihood pattern also shows a marked departure due to the establishment of new industries, increased port activities and opening of private and public offices. The increased urban activities and limited urban amenities have created many problems which invite immediate attention.

110. Geographical zones of Murshidabad.

N. D. BHATTACHARYA, Varanasi.

The object of the present paper is to focus attention on the 'Geographical Zones of Murshidabad'. The present townscape represents different geographical

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personalities in its nature and character of roads, type and density of houses and general pattern of land-use. Keeping these points in view, mainly three 'Geographical Zones of Murshidabad' may be thus distinguished : (i) the inner zone, (ii) the middle zone, and (iii) the outer zone.

Murshidabad-on-Bhagirathi (24° 12′ : 88° 17′), one of the decayed historical cities in West Bengal, lies at a distance of 197 kilometers (122 miles) north of Calcutta. The city was the regional capital of Bengal, Bihar and Orissa during the Moghal period. The geographical factors like site, situation and topography have played their significant role in shaping the social and cultural landscape of Murshidabad.

The inner geographical zone consists of the areas surrounding the Killa-Nizamat as nucleus. There are many palatial buildings, mostly characterised by Muslim designs of mediaeval times. The river-front presents a picturesque aspect.

The middle zone shows a transitional character. Its outer limit is now and then irregular and does not follow any definite boundary. The influence of modernity can be visualised in the immediate vicinity of the Lalbag Court.

The outer zone covers a considerable area from Akbarpur to Moti-Jhil. The cultural landscape of this zone is now characterised mainly by the ruins and remnants of the mediaeval period and hamleted settlements are enveloped by jungles. With the introduction of electricity, a phenomenal change is visualised.

111. Port-Blair—a study in its external and internal relations.

PARMANAND LAL, Varanasi.

Port-Blair (11° 41′N-92° 46′E) is situated along the east coast of the Andaman Islands that are spreading like beads in the blue waters of the Bay of Bengal between 6th and 14th parallels. It is the leading port, the only town and the capital of the Andaman and Nicobar group of Islands.

Port Blair started as a colony with 200 free settlers in the year 1789 established by Captain Archibald Blair of the Royal Navy. In 1857 Port Blair was selected as a Penal Colony which gradually changed into penal settlement with a large number of term convicts from all parts of India and Burma. After independence, Port Blair has become the seat of commercial, industrial and social activities. The present population of the town is 19,000 consisting mainly of Civil employees and traders.

Port Blair maintains her external relations with India and export timbers, match splints, shells, coconuts, copra, rubber and betel nuts. The chief commodities of import are machinery and stores, petroleum products, piecegoods, cereals, cement and building materials from India. The export and import figures totalled 32,735 metric tons in the year 1959-60. It communicates with its hinterland by metalled roads and inter-island transport ships.

112. 'Kaval' towns : A Comparative Study in Functional Aspects of Urban Centres in Uttar Pradesh.

UJAGIR SINGH, Varanasi.

All the five great cities of Uttar Pradesh are river-side towns situated on navigable water channel serving as a source of water supply and water barrier in front, in the centre of Indo-Ganga Plain rightly called 'Madhya Desh' by the Aryans. They possess the advantage of a wide variety of physical endowment characterised by diversity and accessibility. These advantages of site and situation have made the 'Kaval' towns large urban centres. The population of Kanpur

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(947,793) has now reached about a million figure. Lucknow (662,196), Varanasi (573,558), Agra (509,108) are well above half a million, while Allahabad (431,007) has nearly half a million population.

Of five cities, only Kanpur with 42 per cent of population engaged in industry is an industrial city. Lucknow, the capital of Uttar Pradesh with 48·8 per cent engaged in services etc. is an administrative centre. The historic towns of Agra and Allahabad are the old capitals of Uttar Pradesh where more than 40 per cent people are engaged in services etc. They are mainly tourist and administrative centres. Varanasi, with 34·4 per cent in industry, 24 per cent in trade and 31 per cent in services, is a multi functional town.

Zonal distribution of functions of these towns follows more or less the same pattern but greatly differs in details influenced and modified by the physical terran of the site, economic resources of the umland and the historic and cultural traditions of which these cities were the centres. The influence of peninsular character of site of the confluence town of Tirth Raj Prayag (Allahabad), of the crescent shaped Ganga along the Kankar ridge in the sacred city of Varanasi, of the historic remains of the Mughals in Agra, Nawabi traditions and culture in Lucknow, and the impact of rapid industrialisation in Kanpur are clearly marked in the functional landscape of those cities.

(viii) Cartography.

113. Some Problems of Cartographic Generalization.

SIVAPRASAD DAS GUPTA, Calcutta.

Generalization is a fundamental keynote in geographical mapping. A map not only makes a graphic representation of various geographical data but also interprets them through the processes of systematic generalization. In applied cartography several practical problems of generalization are met with, relating to the various kinds and degrees of generalization.

On analysing the different principles of cartographic generalization, it is found that it can be divided into two basic types : (a) physical and (b) classificatory. Physical generalization is largely of qualitative nature and involves the various processes as follows : (i) methodical elimination of unimportant items on maps, (ii) simplification of patterns, (iii) emphasization and exaggeration of important features, (iv) symbolization and diagramatization of items not plottable to scale, etc. Classificatory generalization entails application of various cartographic devices and processes of quantitative nature such as (i) selection of data, (ii) analysis, synthesis and grouping of data, (iii) statistical manipulation of figures, (iv) geographic regionalization, (v) elimination of anomalous data, (vi) adoption of suitable standards, criteria and datums, (vii) approximation of data, (viii) interpolation and extrapolation of data etc.

In application of principles of generalization to cartography, the problems relating to degree of generalization are important. It is quite difficult to strike a balanced degree of generalization on a map, taking into consideration its scale, purpose and the various cartographic limitations in relation to the available mappable data, so as to avoid the common defects of over-, under-, unequal and hasty generalization. Attempts have, therefore, been made to find suitable measures of the degree of cartographic generalization, both quantitative and qualitative. Cartographic generalization also results in certain amount of errors and approximations on maps; the problem of possible minimization and distribution of cartographic errors has also been investigated.

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114. Application of Lambert's Conical Conformal Projection in the National Atlas of India.

NANHE LAL, Varanasi.

In this paper an attempt has been made to assess the preference of Lambert's Conical Conformal Projection for the maps (India) of the National Atlas of India, published in 1957. This projection represents, undoubtedly, a good compromise between the homolographic and azimuthal properties as compared to other universally applied projections, such as Polyconic, for the maps of this country. Percentages of scale errors, farthest from the standard parallels, have been pointed out. This projection, in addition to its wide use during the First World War, was also used for some maps in the Debes' Atlas. The author is, however, of the opinion that the Atlas, being also a source of information for the suitability of various projections for different purposes, would have enhanced its usefulness and educative value by applying some other suitable projections, viz. Oblique Azimuthal Equal Area, Conical Equal Area (Alber's) etc. for the distribution maps. A set of well chosen projections would have served better.

115. Error in Mapping by Isopleth and Choropleth methods.

R. RAMACHANDRAN, Dharwar.

The quantitative distribution maps do not generally represent all the minute variations in a real distribution and therefore involve a certain error. This paper attempts to give a clear definition of this error in quantitative terms.

The process involved in mapping by the choropleth method is essentially a process of continued dichotomy. By this process a region is divided into a number of subregions. A subregion is an area which is geographycally contiguous and wherein the value of the criteria mapped remains within specified limits. A subregion may comprise one or more basic units. Subregions are the final product of mapping and the number of basic units definned in a map will depend upon the number of basic units in it. But by choosing a smaller basic unit it will be possible to define a greater number of subregions. The number of subregions that can be defined by choosing the smallest conceivable basic unit may be called the ultimate number of subregions. The difference between the actual number of subregions and the ultimate number of subregions gives the absolute error in mapping.

Having thus defined the error in mapping, the various factors which contribute to error in mapping are analysed. The important factors are : the size of the region mapped, the homogeneity of the region and the number of basic units used in mapping. The conclusions are summarised in a mathematical form.

116. Statistical Methods in Geography.

M. P. SHREEVASTAVA, Dharwar.

A case has been made in this paper for including a full-fledged paper or practical (dealing with statistical techniques) in post-graduate curriculum for geography at the Indian Universities. Just as a theoretical background of a well-trained geographer consists of an understanding of fundamental principles of many social and physical sciences, he should also be grounded in practically every important technique of problem-oriented research.

A research paper or a thesis or a report by a geographer must be acceptable, if it makes use of only statistical tables and statistical analysis, without any maps

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to go along. More frequent employment of the statistical methods would bring a geographer on par with other social scientists such as economist and sociologist. Maps, which in many cases repeat the statistical analysis, would better is eliminated. Statistics must play an increasing role in the training of geographers.

(ix) Soil Geography.

117. A note on the Physico-Chemical, Textural and Production Potential of Soils in Kashmir valley.

A. N. RAINA, Jammu.

The paper is a reconnaissance survey undertaken to prepare a gemorphic map of the Valley of Kashmir to demarcate the soil boundaries so far as possible. The entire valley of Kashmir, an area of about 8,539 square miles surrounded by the mountains is drained by the Jhelum River and its tributaries. As the altitude rises there are varied soil types from stiffest clay to highest loam yielding a rich harvest.

From Kulgam to Handwara, about 5000′ above sea level (32°17′N. to 36°48′N. and 73°26′ East Longitude to 80°30′ East Lonfitude) is often flooded in spring and autumn upto 6000′ contour that forms an irregular circle passing through Chasmashahi, Dara, Kangam Manasbal, Ajas, Aragam, Sonarwan, Magam, Bumai, Lunderwan, Braman and Sonapath. The area within this flood-contour looks like a mushroom cloud with its tail tapering towards South.

The silt index of the Jhelum River varies in mean diameter from 1·0270 mm. at Sangam to 0·4830 mm. at Naiyon where the Vishav and the Rambiara join the Jhelum.

A field analysis of some of the soil samples reveal colour texture, chemical constituents and respective richness as the altitude rises. Thus a study of the soil nutrients has helped in land utilization. These soil samples are from areas above 6000′ contour revealing that the organic matter decreases in percentage as the altitude rises and the water-holding capacity as well. The results of the examination from the samples show that the soils are degraded podzols and that cultivation is possible even at very high altitude.

An attempt has also been made to correlate, so far as possible, a high density of population in these cultivable alluvial lands to their production potential. From field surveys and spot interrogation the wisdom of centuries preserved in adages revealed an appreciation of practical knowledge of some of the important agricultural operations.

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SECTION OF BOTANY

President : PROF. J. VENKATESWARLU, D.Sc., Ph.D.

Abstracts.

Algae

1. The Compsopogonales in India.

C. R. DAS, Calcutta.

Three species of *Compsopogon* have been studied,—2 of which have already been described by previous workers and one has been discovered. The new report of this freshwater red alga has been described as *C. indica* Sp. nov. is quite distinct from other reported species and has been worked out in greater detail.

Compsopogon is the freswater genus of the family Compsopogonaceae belonging to the order Compsopogonales the members of which are found growing in freshwater habitat. It has been placed in the Uncertain Bangiales,—an undecided systematic position among the members. An idea of its taxonomy has been drawn in the paper, with a key to the reported species from India. The report of tetrasporangium in *Compsopogon* is also for the first time from India.

An oil of vigilant interest on chemical analysis has been obtained from a species of *Compsopogon* and as such the genus has been put to further inquiry.

2. Further study of the Algal Flora of Cuttack.

H. PATTNAIK and B. N. MISRA, Cuttack.

The drains of Cuttack, which are poorly maintained, are the good habitats for the algal flora to flourish well. There are a large number of ditches and ponds which collect rain water and are also suitable habitats for the algal flora. In this paper 20 species of different groups of Algae have been described. Among the different groups Chlorophyceae has the largest number of species and Bacilariophyceae has been represented only by Diatoms of different sizes belonging mostly to Pennatae.

In summer the organisms remain in zygote stage or in a resting stage. At the beginning of winter, when the water remains almost stationary, the Algal flora flourishes well. In spring season maximum development of the Algal vegetation can be seen.

3. Diatoms from the Pleistocene Clay Deposits of Kashmir. Part II. Pennate Diatoms.

A. R. RAO and PRITI AWASTHI (MISS), Lucknow.

The present communication, describes, figures and lists the species of Pennate diatoms occuring in some Pleistocene clay deposits of Kashmir (INDIA). Most of the specimens are fragmentory. Descriptions are based on the most perfect specimens occured in the clay. Provesional identifications show that the assemblage covers at least eleven genera, specific identification of these are in progress, follow-

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ing are the genera *Fragilavia, Caloneis, Navicula, Pinnularia, Epithemia, Hantzschia, Diploneis, Eunotia, Cocconeis, Gyrosigma* and *Cymbella.*

4. Diatoms from the Pleistocene Deposits of Kashmir (India). Part I. Centric Diatoms.

A. R. RAO and PRITI AWASTHI (Miss), Lucknow.

Although the Pleistocene microfossil flora of Kashmir has been investigated by various workers after the discovery of Godwin Austen (1859). Not much has been done on its flora. Cogner (De Terra and Pattersen) recorded some diatoms from the Pleistocene deposits of Kashmir. In the present investigation two clayey blocks obtained from a new locality laradura were analysed. The centric diatom so far identified, have been described and figured, are *Melosira ambigua, Melosira sp. 1, Melosira sp. 2, Melosira sp. 3, Cyclotella meneghiniana, C. comta, C. Comta var affinis, C. iyengaria* sp. nov, and *Stephanodiscus astraeae.* Most of these are fragmentory but some of these complete frustules admit specific identification.

Mycology and Plant Pathology.

5. Fungi causing plant diseases at Jabalpur (M.P.). VIII.

G. P. AGARWAL, Jabalpur.

The present paper describes five more parasitic Deuteromycetes causing leaf spot at Jabalpur. *Phyllosticta hasijai* Agarwal on *Acacia melanoxylon* R. Br. and *Cercospora anisochilicola* Agarwal on leaves of *Anisochilus eriocephalus,* are the two new species described in detail. *Phyllosticta hasijai* sp. nov.—Pycnidia fusce brunnea, globosa vel lenticularia, ostiolata, 46·5-245 μ diam., mediet. 167·7 μ ; conidia hyalina, unicellularia, ovalia vel cylindrica, 3-18·3 × 2·9-3·1 μ, mediet. 6 × 3 μ. *Cercospora anisochilicola* sp. nov.—conidiophori fasciculati, evoluti ex stromatibus densis, erecti, simplices vel furcati, septati, geniculati, 25·6 – 102·4 μ longi, mediet. 89·6 μ ; conidia hyalina, filiformia, recta vel curvata fastigata in apicem terminalem, 2—16 septata, cicatrice monstrante punctum unionis praesente ad basin, 32—154·4 × 3·2 – 5·6 μ, mediet. 85·5 × 4·5 μ. *Cercospora fasminicola* Mueller & Chupp on leaves of *Jasminum* sp. and *C. achyranthina* Thirum. & Chupp on leaves of *Achyranthes aspera* are two new records for the State and *Pestalotiopsis glandicola* (Cast.) Steyaert on leaves of *Cassia tora* L. is a new addition to the fungus flora of India.

6. Studies on the Fusarium Wilt of Ipecac in the field.

H. K. BARUAH, MUNIN CHETIA and G. SATYANARAYANA, Gauhati.

Psychotria ipecachuna Stokes, commonly known as Ipecac, belongs to Rubiaceae. It is a well-known medicinal plant valued for the many alkoloids of which Psychotrine and Ematine are the most important. It is introduced into Assam recently and is cultivated at Nangpoh in the Khasi and Jayntia hills. The plants at the sight of cultivation were reported to be dying after developing a wilt symptom in the field. The present investigation deals with the identification and isolation of the pathogen from the wilted plants. The pathogen is identified to be the soil-born *Fusarium solani.* The pathogenicity experiments conducted with the organism isolated from the wilted plants produced disease symptoms similar to those observed in the field. Control methods are under progress.

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7. Field observations on the incidence of *Fusarium* Wilt of gram *(Cicer Arietinum* L.) in relation to soil conditions.

S. K. CHAUHAN, Agra.

The observations were recorded at B. R. College, Bichpuri Farm, Agra pertaining to soil temperature, soil moisture, soil pH and disease intensity in two fields (healthy and diseased) simultaniously at regular intervals of fifteen days during the period of optimum disease development in relation to wilt of gram (*Cicer arietinum* L.) caused by *Fusarium orthoceras* var *ciceri*. It has been noted that for a considerable long period of the crop the soil temperature ranges (24°-28°C) were present in wilt affected field as also observed by Jones *et al* (1926) for other vascular wilts. However, no significant relationship has been observed between the wilt incidence and soil pH and moisture of the fields. It seems that various soil factors act jointly and interact as pointed out by Rishbeth (1955) in Pannama disease. The tempo of disease is studied by appraising its intensity at the same regular intervals. Further, it may be pointed out that frequency of population of *Fusarium orthoceras* var. *ciceri* was almost negligible in the soil of healthy field and abundant in diseased one under observation.

8. Role of soil organic matter (Humus) in wilt of gram *(Cicer Arietinum* L.) caused by *Fusarium Orthoceras* var. *Ciceri*.

S. K. CHAUHAN, Agra.

Wilt of gram (*Cicer arietinum* L.) caused by *Fusarium orthoceras* var. *ciceri* has been studied in relation to soil organic matter (humus). The percentage humus was altered by adding municipal compost in soil in various proportions, and humus percentage in five such samples was determined as suggested by Wakesman (1952). The values being 16·40, 13·70, 12·53, 11·00 and 8·27% humus content. Soil of these samples was filled-in in pots and infested with the pathogen and then 7 seeds were sown in each pot. Six replications of infested and noninfested (control) were kept.

Final mortality figures were recorded in each pot of each treatment and the data analysed statistically. However, no plant wilted in the control. By changing the percentage humus content of soil the ptrcentage mortality also changed. The percentage mortality is inversely proportional with the percentage amount of humus in the soil. The order of reduction being 90·51 > 69·11 > 57·20 > 38·13 > 19·11 in various combinations respectively. As the data found to be statistically significant the C.D. was also calculated, which was 16·36.

9. Effect of soil moisture on the incidence of fusarium wilt of gram *(Cicer Arietinum* L.)

S. K. CHAUHAN, Agra.

Influence of four leavels of soil moisture, well within the water holding capacity, viz. 10, 15, 20 and 25% (on oven dry weight) was observed on the wilt mortality in gram (*Cicer arietinum* L.) caused by *Fusarium orthoceras* var. *ciceri*. Weighed glazed metal pots were filled with 6 lbs. of soil and various moisture levels were maintained by weighing. The soil was infested in the usual way and five seeds were sown. Six replications were kept throughout the course for each treatment and its control. The data obtained on final mortality were analysed statistically and found to be significant.

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The maximum percentage mortality of 83·33 was at 25% soil moisture level and it decreased considerably in lower levels. The order of reduction in the percentage mortality being at 25%—83·33 > 20%—36·66 > 15%—26·66 and at 10%—13·83. The C.D. for the figures being 14·71.

10. Studies on Penicillin—IV. Utilization of Monosaccharides by Some Non-overticillate Penicillia.

DINESH KUMAR, Allahabad.

The utilization of some monosaccharides given alone and in mixture with sorbose were studied in the case of *Penicillium levitum* Raper and Fennel, *P. sclerotiorum* van Beyma, *P. citreo-viride* Biourge and *P. cyaneum* (B. and S.) Biourge. Where as maximum yield was obtained on fructose, sorbose was found to be the poorest of all sources tried. The behaviour of these molds was different on rhamnose as compared to arabinose and xylose, presumably due to presence of CH^3 group in it. Whereas glucose and galactose were better utilized in the presence of sorbose, the utilization of fructose, xylose and arabinose was inhibited in general. Only *P. citreo-viride* could utilize all the monosaccharides better in presence of sorbose.

11. Newly reported fungi from Orissa—I.

G. R. GHOSH and B. G. DUTTA, Cuttack.

I. *Tryblidiella rufula* (Spreng.) Sacc. on *Citrus aurantifolia* (Christm.) Swingle and *Citrus* sp.

The fungus has been found growing on dead twigs of *Citrus aurantifolia* (Christm.) Swingle at Cuttack and *Citrus* sp. at Barang.

Apothecia loosely scattered to gregarious, erumpent then superficial, elliptical ovate, opening by a cleft, hard, black, 1-2 mm long × 0·5-0·8 mm broad; stroma lacking; hypothecium well developed, thick; asci cylindric, 8-spored, 105·5-122·4 × 9·5-12 μ; paraphyses numerous, hyaline, mostly unbranched, but sometimes branched at the tip; ascospores oblong ovate, straight, sometimes slightly bent, uniseriate, mature spores three septate, slightly constricted at each septum, 20·5-23 × 7-8·5 μ, smoky, smooth, thick walled, dispersing at maturity through an apical pore in the ascus.

2. *Trabutia butleri* Theiss & Syd. on leaves of *Ficus religiosa* L.

Perithecia epiphyllous, sunken in stroma, reduced to polyascous locules with ostioles; stroma irregularly disposed on the leaf, sparse to gregarious, 6-17 mm in extent, plano-conves, black, sinuous, forms a shield shaped black mass around the perithecia resembling a clypeus; asci cylindric ovate, 48159 × 18-24 μ, interspersed between numerous slender, long, hyalin paraphyses; ascospores hyaline, 1-2 seriate, elliptical to pyriform, 14·5-18 × 9·5-12 μ.

The authors wish to thank Dr. J. C. F. Hopkins, Director, Commonwealth Mycological Institute, Kew, England, for kindly identifying the fungi.

12. Newly reported fungi from Orissa—II.

B. G. DUTTA and G. R. GHOSH, Cuttack.

1. *Fruit rot of pome granates.*

Fruit rot of Pome granate (*Punica granatum* L.) as reported here from Bhadrak, District Balasore, is caused by a fungus identified by the authors to be *Aspergillus*

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foetidus Thom & Raper. The fungus was cultivated on Czapek's solution agar. Cultural, morphological characters and mode of infection etc. are described in details in the paper.

Fruit rot in Pome granates has been reported previously from India by Butler (1914) who states the fungus responsible as *Aspergillus castaneus* Patterson. In Saccardo (1902) the fungues is named as *Sterigmatocystis castanea* Patterson, but Thom and Church (1926) state this fungus to be a strain of the *Aspergillus niger* group. The disease under report is caused by a fungus which is also a member of the *Aspergillus niger* group but is not *Aspergillus castaneus* Patterson, as reported previously.

2. Seedling blight of *Ipomoea carnea* Jacq.

Seedling blight of *Ipomoea carnea* Jacq. is caused by *Fusarium nivale* (Fries) Cesati. The fungus makes its first appearance on the host only after the seed coat has broken apart (treatment by B. Misra, Cuttack) and the radicle has just started to come out. Slimy spots appear on cotyledons, seed coats and radicle. The radicle gets rotten first leading to the death of the seedling. In late invasions, the first two leaves and others are also attacked. The fungus was cultivated on Czapek's solution agar. The morphological and cultural characters are discussed in detail in the paper.

13. Myxomycetes from Orissa.

G. R. GHOSH and B. G. DUTTA, Cuttack.

The following Myxomycetes have been collected and identified from Cuttack, and are being reported for the first time from Orissa, the asterisked ones are new additions to Indian Myxomycetes.

1. *Arcyria cinerea* (Bull.) Pers.
2. *Hemitrichia stipitata* (Massee) Macbr.
3. *Diachea leucopodia* (Bull.) Rost.
4. *Phyasarum nicaraguense* Macbr.
*5. *Stemonitis flavogenita* Jahn.
*6. *Didymium vaccinum* (Dur. & Mont.) Buchet.
*7. *Didymium minus* (Lister) Morgan.
*8. *Cribraria splendens* (Schrad.) Pers.
*9. *Elaeomyxa* sp. (described below).

Habitat : on dead rotten wood.
Plasmodium : not observed.
Fructification : sporangiate.
Sporangia : gregarious, stalked, cylindric, apex-obtuse ,dirty white, iridescent, up to 1·5 mm long; stalk long, erect, black; columella limeless, almost black, about half the height of the sporangium, swollen at the tip.
Capillitium : arising mostly from the swollen part of the columella, dark, purplish brown, anastomosing threads with cream coloured, granular wax deposits.
Spores : violet by transmitted light, warted, 6-7 μ in diameter.

This species is not a very common one in the locality. It differs from the existing species *Elaeomyxa miyazakiensis* (Emoto) Hagelst. in the colour of the sporangia and wax. But it is not yet certain whether this difference is a varietal difference or the described organism should be raised to a specific rank. The material is under study.

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14. Soil fungi from the paddy fields of Orissa.

G. R. GHOSH and B. G. DUTTA, Cuttack.

Orissa is a state where paddy is the most important crop. Generally two crops are grown in this state, one is the main crop, sown in June and harvested in December, the other one is the 'Dalua' crop, which is sown in December and harvested in March or early April. An investigation into the fungus flora of the paddy fields has been undertaken. The present paper deals with the fungal flora of the 'Dalua' season only.

Out of the 77 fungi isolated from two paddy fields 38 are new additions to Indian soil fungi. Only the new reports are mentioned here :

PHYCOMYCETES

Achlya deBaryana Humphrey, *Mucor fragilis* Bainier, *Podochytrium clavatum* Pfitzer, *Podochytrium lanceolatum* Sparrow, *Pythiopsis cymosa* de Bary.

ASCOMYCETES

Chaetomium homopilatum Omvik, *Chaetomium olivaceum* Cooke & Ellis, *Pseudoarachniotus* sp. (orange), *Pseudoarachniotus* sp. (red).

DEUTEROMYCETES

Aspergillus clavatus Desm., *A. gracilis*)Bainier, *A. unguis* (Emile-Weil & Gaudin) Thom & Raper, *Botryotrichum* sp., *Botrytis bassiana* Balsamo, *Cladosporium herbarum* (Pers.) Link, *Curvularia pallescens* Boedijn, *Geotrichum candidum* Link, *Geotrichum flavo-brunneum* Miller, Giddens & Foster, *Gliocladium penicilloides* Corda, *Gonytrichum macrocladum* (Saccardo) Hughes, *Haplochalara* sp., *Hormiscium gelatinosum* Hedgcock, *Penicillium chermesinum* Biourge, *P. deleae* Zaleski, *P. purpurogenum* Fleroff-Stoll, *P. restricum* Gilman & Abbott, *Penicillum rugulosum* Thom, *P. sclerotiorum* van Beyma, *P. tardum* Thom, *P. varians* Smith, *P. velutinum* van Beyma, *P. warsmani* Zaleski, *Sepedonium chrysospermum* (Bull.) Fries, *Spicaria* (Thom) Gilman & Abbott, *Spicaria sylvalica* Oudemans, *Tetracoccosporium paxianum* Szabo, *Verticillum cellulosae* Daszewska, *Verticillium terrestre* (Link) *Lindau.*

15. Gymnoascaceae from India—3.

G. R. GHOSH, Cuttack, H. H. KUEHN U.S.A. and G. F. Orr, U.S.A.

The study of Gymnoascaceae has hitherto been neglected mainly due to the difficulty in isolation. By the isolation techniques developed by the authors, it has been possible to isolate a large number of Gymnoascomycetes (maximum by G. F. Orr). Among the Indian isolates three new reports are being presented here :

G5 is a species of *Pseudoarachniotus,* isolated from mouse dung. The fungus is bright golden yellow on the dung. On the basis of the colour and ascospore characters a new species is proposed. The ascospores are bright golden yellow, elliptical, to globose, in surface view, echinulate over the entire surface, 3·5-5 × 2·5-3 μ. *P. citrinus* has lemon yellow smooth spores.

G6 has bright reddish orange growth on the mouse dung. The hyphae are thick and septate which are suggestive of a loose peridium similar to previous isolates GI and GII. Hence the position is doubtful, but the characters are worthy of a new genus. The ascospores are 4-5 × 2·5 μ, elliptical, orange and with a medium raised band on the long axis.

G7 is a bright red fungus isolated from bat dung (Puri, Jagannath temple). On the peculiar adorations of the ascospores, which differ from *Pseudoarachniotus*

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roseus, a new species of *Pseudoarachniotus* is proposed. The ascospores are bright red, apiculate, elliptical, with two distinct bands on each axis which make them appear angular at four corners, 5-7 × 3·5 μ.

Other characters are discussed in details in the paper.

16. Gymnoascaceae from India--4 : two new species of *Pseudoarachniotus* from soil.

G. R. GHOSH and B. G. DUTTA, Cuttack.

1. *Pseudoarachniotus* sp. nov.

Growth on Sabouraud's P.S.A., cottony, at first white, then through cream, light yellow, golden yellow to deep orange in colour. The asci appear entangled in knots of hyphae. Discrete peridial hyphae lacking.

Asci : globose to pear shaped, 12-14 × 10-14 μ, 8 spored, wall evanescent when mature, orange in transmitted light.

Ascospores : yellowish when young, orange coloured with maturity, smooth, elliptical, with an equatorial band, 5-7 × 3·5 μ.

2. *Pseudoarachniotus* sp. nov.

The fungus described here does not fit in exactly in the genus and may have to be put in a new genus similar to G_1 & G_2.

Growth on Sabouraud's P.S.A. gregarious, discrete cleistothecia like balls are observed. Peridial hyphae)slightly thickened, hinge like. Racquet mycellum present.

Asci : globose, 10-12 μ in diameter, 8 spored.

Ascospores : red, distinctly spinulose, spines long, the spore appears roughned in low magnification, globose, 5-6 μ in diameter.

The above two species differ from the known species of *Pseudoarachniotus*, hence they are proposed to be new.

17. Influence of date of sowing on disease intensity and crop loss estimate of tumour Disease of coriander.

J. S. GUPTA, Agra.

The present study deals with the influence of time of sowing on disease intensity and crop-loss in *Coriandrum sativum* L. caused by *Protomyces macrosporus* Ung. Three sowing dates were tried extending over a period of one and half month (first sowing : 1st November; second sowing : 25th November and third sowing : 20 December). Seeds of variety no. I.C. 3622 were sown in beds designed on random block method and results analysed statistically. Controls (plants) raised in uncontaminated soil) were maintained for each sowing. In the infected sets, soil was contaminated with suspension of chlamydospores obtained by crushing 2·5 gms. of completely diseased fruits in one gallon of water.

Total disease intensity and also disease intensity on stem, pedical and fruits separately were appraised in the plants grown in inftested beds. Height of plants, shoot dry weight at harvest, yield of fruits and number of seeds set in healthy and diseased plants were noted. Comparisons were also made between disease intensity and growth and yield characters.

Total disease intensity and that on stem, pedical and fruits separately varies with the date of sowing. Delay in sowing by about three weeks results in greater disease intensity (53%) compared to normal sown plants in the first week of November. Very delayed sowing (third sowing in the third week of December)

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causes a decrease in disease intensity (12·8%) but the plant growth is depressed considerably.

Under conditions of normal sowing (first sowing) the disease intensity on stem, pedicel or fruits is almost equally distributed. In the late sowings (second and third) a greater disease intensity on fruits in contrast to stem or pedicels was observed.

A direct relationship between disease intensity and loss in yield has been noticed, an increase in disease intensity results in increased loss in yield of fruits. Maximum loss of 67·7% with the maximum disease intensity of 53% was recorded in the second sowing (third week of November). Loss in yield is attributed to decrease in total number of fruits set, wastage of fruits due to hypertrophy or atrophy and also due to shrivelling of fruits produced by the infested plants.

18. Histopathological changes in fruits of coriander infected with *Protomyces Macrosporus* Ung.

J. S. GUPTA, Agra.

The changes in the fruits of *Coriandrum sativum* L. inftcted with *Protomyces macrosporus* Ung. depend solely upon the time of infection of parasite and developmental stages of the fruits. In fully hypertrophied fruits the distinction into various layers of pericarp is lost. The epidermis elongates periclinally and the sclerencymatous layer so prominent in healthy fruits is lacking altogether. The xylem appears stretched. The dorsal vittate lie deeper in the tissues due to hypertrophy of the latter and lose their distinct shape. A great increase in size of the carpophore and stylopods is seen and the oil ducts are absent. The longitudinal splitting of the carpophore characteristic of a healthy ripe fruit does not take place in fully hypertrophied fruits as a result of which there is no separation into two mericarps.

The testa shrivels up while the endosperm and the embryo are lacking in hypertrophied fruits. In partly infected fruits when the infection reaches late the endosperm is formed but the size of its cells increases and granular matter in the cells appears. Less hypertrophied fruits show presence of shrivelled endosperm with poorly differentiated embryos.

Germination tests reveal that fully or relatively less hypetrophied mature fruit (seeds) do not germinate while partly infected seeds are viable.

Following Kuster's (1910, 1911 and 1925) concept of classification the galls formed by *Protomyces macrosporus* on fruits of *Coriandrum sativum* L. can easily be placed under the prosoplasmatic type of histioide galls. The observations are in line with the study of galls on *Crepis japonica* and *Lactuca debilis* infected by *Protomyces Inouyei* and *Protomyces Lactucae-debilis* (Akai, 1939) respectively.

19. Some foliicolous Deuteromycetes from Rewa (M.P.).

S. K. HASIJA, Rewa.

Some Fungi imperfecti causing leaf spots at Rewa have been described in this paper. It includes *Phyllosticta solani* Hasija, a new species, on *Solanum melongena* L. Pycnidia are 67·2–200 μ in diameter and conidia 12·8–22·4 × 4–6·4 μ, average 17·5 × 4·8 μ, *Colletotrichum capparidis* Hasija on *Capparis sepiaria* L. is another new species described. Acervuli are 46·2–99 μ in breadth, conidia hyaline, single celled, cylindrical and 13·2–16·5 × 3·3–6·6 μ, average 15·2 × 4·8 μ. The latin diagnoses of the new species are given. *Urochloa reptans* for *Colletotrichum graminicola* (Ces) Wilson and *Heteropogon contortus* Beauv. for *Curvularia lunata*

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(Wakker) Boed. are new host record from India. *Helminthosporium capense* Thumen, a hyperparasite on *Meliola* sp. on the surface of *Citrus* leaves is a new record for the state.

20. Studies on apple seedling blight, *Sclerotium Rolfsii* Sacc., in Himachal Pradesh.

S. S. JAIN, Solan.

Seedling blight of apple has been observed in several nurseries in Himachal Pradesh. Isolations made from the diseased roots and collar readily yielded *Sclerotium rolfsii* Sacc., the pathogenicity of which was established. The disease causes heavy losses of nursery stock. Recently, losses upto 50% of young plants were observed in a nursery at Khalini, Kasumpti (Mahasu District). The disease is favoured by warm, humid weather, especially in ill-drained and shady places. At lower elevations (3500'—4000 a.s.l.), it appears during July to September(while at higher elevations (6000' a.s.l.), the infection is observed during April to June. The disease perpetuates by means of sclerotia. Change of site of the nursery to a plot not previously used for raising apple stocks was found to be a good preventive measure. Tests with soil disinfectants, such as Shell D-D Soil Fumigant (200 lb./acre), Cheshunt compound (2 oz./gal.), formalin (1 lb./3 gal.) mercuric chloride (1 lb./100 gal.) were conducted during 1958 to 60 at the Govt. nursery. Nagwain (3500' a.s.l.), where the disease assumed alarming proportions, to assess their comparative efficacy in controlling the disease, and also to study their effect on the germinability of apple seeds. The chemicals were applied to the soil @ ½ gal./sq.ft. about 3 weeks before planting. Cheshunt compound was further applied thrice during July-August. The results indicated that none of the chemicals had any adverse effect on the germinability of seeds, but rather had a beneficial effect on germination. The percent germination under different chemicals ranged from 8·9 to 11·1, compared with 6·3 in the untreated. Both formalin and Cheshunt compound, being equally effective, gave good control of the disease, the average mortality being 1·25%, followed by mercuric chloride with 2·50%. Shell D-D, though least effective, was notable superior to the control, the average mortality being 6·25% and 16·25%, respectively. Removal and destruction of diseased plants, avoidance of shade, water-logging and thick planting in, and frequent hoeing of nursery beds, rotation, and disinfection of soil with Cheshunt compound or formalin are recommended as measures for control.

21. On the possible role of Oxalic acid metabolite in the causation of wilts of guar *(Cyamopsis Psoralioides* DC.) and gram *(Cicer Arietinum* L.) by *Sclerotium Rolfsii* Sacc.

S. B. MATHUR and S. SINHA, Agra.

The role of toxins in causing wilts by certain soil fungi is now fully established. *Sclerotium rolifsii* is known to cause wilt of guar (*Cyamopsis psoralioides* DC.) and gram (*Cicer arietinum* L.). Cultures of this fungus produce oxalic acid which has been found to toxic to the hosts. Knowing the toxic nature of oxalic acid, several workers have suspected it to be responsible for the death of host plants. In the present investigation experiments were carried out to see the effect of synthetic and metabolite oxalic acid on seedlings of guar and gram on the causation of wilt.

Oxalic acid was synthesized by the fungus on Richard liquid medium and the filtrate showed the presence of oxalic acid which was detected by chromatography. Seedlings of guar and gram were grown first in three salt Shive solution and later on transferred to another series with the nutrient solution having the filtrate in

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varying proportions. Both guar and gram showed typical wilting symptoms. The toxic substance was thermo-stable, non-volatile and its effect decreased with dilution of the filterate. Another set of similar experiments was conducted in which synthetic oxalic acid was used instead of the filtrate and typical symptoms of the wilt were obtained in this case also.

From the present studies it is quite evident that oxalic acid is one of the causes for the wilting of guar and gram when infected with *Sclerotium rolfsii*.

22. Utilization of Sugars in Mixtures by Some Monoverticilliate Penicillia.

B. S. MEHROTRA and DINESH KUMAR, Allahabad.

The utilization of some sugars, when supplied in different mixtures, by *P. levitum* Raper and Fennell, *P. sclerotiorum* van Beyma, *P. citreoiviride* Biourge and *P. cyaneum* (B. and S.) Biourge was studied. These fungi, which are closely related morphologically showed different rate of assimilation of these sugars but they were generally akin in their preference towards the sugars when supplied in a mixture. Lactose and sorbose were the last to be utilized. Galactose, which is utilized slowly when supplied singly, is preferentially utilized from the mixtures by these fungi. Of the two pentoses, xylose and rhamnose, former was finished earlier, by these moulds except by *P. citreo-viride* which utilized rhamnose earlier than xylose. The results of the present study support the view that it is easy for fungi to secrete several enzymes in small quantities than one single enzyme in large quantity.

23. Occurrence of *Colletotrichum lindemuthianum* (Sacc. & Magn.) Briosi and Cav. on *Cassia fistula* L.

N. N. MOHANTY and B. C. BEHERA, Bhubaneswar.

A severe leaf spot disease of *Cassia fistula* L. caused by *Colletotrichum lindemuthianum* (Sacc. & Magn.) Briosi and Cav.=*Glomerella lindemuthianum* (Sacc. & Mag.) Shear was noticed in Khandagiri Hills near Bhubaneswar (Orissa) during October, 1960. The disease is characterised by the appearance of circular greyish-white spots with dark-brown narrow margins. The conidiophores of the fungus are hyaline, unbranched, unseptate, tapering towards tip and measure 3-4 × 17·5–35 μ. The conidia are hyaline, one celled, oblong to ovate with rounded ends, straight or slightly curved and measure 2-6·5 × 12-20 μ. Although the fungus has been recorded on *Phaseolus vulgaris* and on some other hosts from India, its occurrence on *Cassia fistula* L. appears to be a new record.

24. Ultraviolet induced mutations in *Rhizopus oryzeæ*.

P. NANDI, Miss K. BHATTACHARYA and A. K. MISHRA, Calcutta.

Work has been undertaken with *Rhizopus oryzeae* a Phycomycetous fungus producing lactic acid. It has a fast and spreading growth and colony counts are difficult to make, as all small colonies merge to form a bigger one. By trying different media and chemicals it has now been possible to get compact colonies of the fungus. The following media was developed—Glucose—40·0 gms ; KH_2PO_4—0·3 gms ; NH_4NO_3—1·2 gms ; $MgSO_4$—0·12 gms ; Ferric tartarate-0·003 gms ; NaCl—90·0 gms ; distilled water—1000 ml ; pH adjusted to 6·0. Percent survival of the spores of *R. oryzeae* with UV at an intensity of 100 ergs/mm²/sec was 46·3%,

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20·0%, 0·2% and 0·2% for 1,2,3 and 4 minutes of irradiation respectively. A number of lactic acid variants have been obtained, the detailed studies are in progress.

25. Colletotrichum on Chilli Fruits.

B. PADHI, Cuttack.

Chilli (*Capsicum annuum* L.) fruits have been found to be very severely affected by *Colletotrichum* in several fields of Cuttack in the rainy season of 1961. The symptoms are, more or less, like those of the "Ripe Rot", except that the acervuli develop gregariously and irregularly. The calyx cup and the stalk are, in quite a few cases, attacked and show the signs. Brown setae, upto 150 μ long, develop all over the erumpent acervuli, variable in size and shape. Colourless, entire and crescent shaped condia are 20μ to 25μ long. The fructification characters correspond to those of *C. capsici* Syd. which usually causes "Die Back" or "Anthracnose". Hence the fungus, under report, shows interesting linking characters and further studies are being undertaken.

26. The genus *Physoderma* Wallr. in Maharashtra.

S. D. PATIL, Poona.

Till 1949 the genus *Physoderma* Wallr. was believed to be represented in the old Bombay State by a single species. *Physoderma maydis* Miyabe occuring on the leaves of *Zea mays*. (Patel, Kamat and Bhide, 1949). In 1959, Thirumalachar et al recorded three more species from this State to which Thirumalachar and Pavgi (1956) added five new species mostly from Poona making a total of nine species for the Maharastra area. They are as follows :—

1. *Physoderma aeschynomenis* Thirumalachar and Whitehead on *Aeschynomene Indica* L.
2. *Physoderma bothriochloae* Thirum. & Pavgi on leaves of *Bothriochloa pertusa* (L.) A. Camus.
3. *Physoderma chrysopogonicola* Thirum. & Pavgi on leaves of *Chrysopogon* Sp.
4. *Physoderma cynodontis* Pavgi and Thirum. on leaves of *Cynodon dactylon* Pers.
5. *Physoderma dicksoni* Thirum. & Pavgi on leaves of *Iseilema laxum* Hack.
6. *Physoderma echinochloae* Thirum. & Whitehead on *Echinochloa crusgali* Beauv.
7. *Physoderma maydis* Miyabe on leaves of *Zeamays*. L.
8. *Physoderma narsimhanii* Thirum. & Pavgi on leaves of *Dactylotaenium aegypticum* Richt.
9. *Physoderma paspalidii* Thirum. & Pavgi on leaves of *Paspalidium geminatum* Stapf.

In addition to these nine species the author collected six more from near about Poona and Karad (District-Satara).

10. *Physoderma commelinae* Lingappa on the leaves, leaf sheaths and stem parts of *Commelina ferskalaei* Vahl.
11. *Physoderma corchori* Lingappa on stem, petioles and leaves of *Corcorus acutangularis* Lam.
12. *Physoderma dicanthicolum* Pavgi and Thirum. on leaves of *Dicanthium annulatum* (Forsk.) Stapf.
13. *Physoderma nelumbi* Misha and Thirum. on leaves of *Nelumbium speciosum* Wild.

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14. *Physoderma setaricola* Pavgi & Thirum. on leaves of *Setaria glauca* Beauv.
15. *Physoderma schroeteri* Krieger on leaves of *Cyperus rotundus* Linn.

The genus thus seems to be represented by about 15 species now of these six constitute new records for the State. Two new host records are also given viz. *Commelinae ferskalaei,* and *Cyperus rotundus* for *Physoderma commelinae* and *Physoderma schroeteri* respectively.

27. Anthracnose of *Pithecolobium dulce* Linn.

R. Y. ROY and R. S. DWIVEDI, Varanasi.

This paper deals with a report of a member of *Colletotrichum* causing disease on *Pithecolobium dulce* Linn. ccollected from Allahabad city. The infection spots on leaves are circular to irregular varying from 2-15 cm. When the disease is severe, spots coalesce forming a broad patch and sometimes a shot-hole condition also prevails. Margin of the spot is somewhat raised, dark yellow, enclosing a dull grey centre. Acervuli sub-epidermal, dark brown, 30-90 μ, surrounded by light-brown to deep brown, two to three septate setae. Latter with bulbous base and with tapering apex, straight or slightly curved, 42-160 × 3·4-6 μ and intermixed with simple, hyaline conidiophores. Conidia hyaline, sickle shaped with pointed ends, non-guttulate and vary from 16·5-20 × 2·6-3·3 μ.

Roldan (1936) had reported a new species (*C. pithecolobii* sp. nov.) on the same host from the Philippine islands. The present fungus differs from Roldan's species in bearing (i) light brown to deep brown, two to three septate setae as against the black and non-septate setae of the Philippine's species, and (ii) smaller conidia. These differences are so obvious that it may be considered a new variety and tentatively it is being named *C. pithecolobii* var. *indicum* var. nov. Further work is in progress.

28. The genus *Caldariomyces* : A new report on *Cassia tora* Linn.

R. Y. ROY and R. S. DWIVEDI, Varanasi.

Cassia tora Linn. has been observed to be infected by a member of *Caldariomyces* in a locality near Durga-kund of Varanasi city. The pathogen was collected in September of 1960 and again in the same month of this year. The infection spots are black and are confined to the stipels on the rachis. Severity of the disease increases with the increase in dampness in the atmosphere and as a result the infection spots spread on the rachis. Conidiophores are synnemate-like in appearance, brownish-green, simple or branched, broad at the basal region and narrow towards the apex, sometimes proliferate into secondary ones, vary from 140-470 × 10·4-40 μ, and bear sub-globose pycnidia at tips. Pycnidia are greenish-brown and rupture at maturity liberating globose to sub-globose conidia which very from 3·5-7 × 3·5-4 μ. This fungus differs from the other species described by Dwivedi (1960) in the profused proliferating and branching habits of conidiophores and bearing smaller conidia. Further work is in progress.

29. Studies on Sphaeropsidales. IV. Effect of temperature, carbon and sulphur requirements.

R. K. SAKSENA and DINESH KUMAR, Allahabad.

The effect of temperature and different carbon and nitrogen sources on the growth of four members of Sphaeropsidales, viz., *Botryodiplodia* sp., *B. theobromae, D. cajani* and *M. phaseoli* was noted.

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While the minimum temperature was between 10°C and 15°C the optimum temperature was 30°C. The upper limit of temperature range was 40°C for *Botryodiplodia* sp. and *B. theobromae* and 45°C and 50°C for *Macrophomina phaseoli* and *Diplodia cajani*. The rate of growth of these organisms increased with the rise of temperature till 30°C. None of the present fungi showed a constant rate of growth under constant conditions.

Amongst the pentoses (carbon sources) arabinose, was preferentially utilized over xylose. On the other hand, of the hexoses dextrose was good source for *Botryodiplodia theobromae* and *Macrophomina phaseoli* while mannose was good for *Botryodiplodia* sp. and *Macrophomina phaseoli*. For the rest of the organisms dextrose was moderate and mannose was a poor source of carbon. The disaccharides —sucrose and maltose—were good sources for most of the organisms studied. Of the two polysaccharides dextrin was good for all the present fungi while starch varied from good to poor for different fungi investigated. Sorbitol was good for the growth of majority of the fungi, but mannitol and glycerol were poor sources for most of them. Except for *Diplodia cajani* which grew well on tartaric acid, none of the present fungi showed any liking either for malic or tartaric acid.

While studying the sulphur requirements it was found that out of the inorganic sources potassium sulphate and sodium hyposulphite were good sources for all the fungi except *Botryodiplodia* sp., but sodium sulphite was good only for *Diplodia cajani*. Sodium thiosulphate supported good growth of majority of present organisms. However, sodium bisulphite proved to be good for *Diplodia cajani* and *Macrophomina phaseoli* only. Amongst the organic sulphur compounds cystine did not support any growth of these fungi, thiourea was a poor source for *Botryodiplodia* sp. and *Diplodia cajani* and methionine was good for all of them.

30. Studies on the Periodicity of occurrence of certain Fungi from the Soils of Gauhati—Assam.

G. SATYANARAYANA and H. K. BARUAH, Gauhati.

During the course of a study on the evaluation of soil fungi from the soils of Gauhati, a very interesting phenomena was observed in the mode of occurrence of Aspergilli, on the basis of soil dilution technique. Four species of Aspergillus constituted nearly 40 per cent of the total soil fungal population. However, strangely the aspergillus population was not constantly available in the soil. During the cold months of December, January and February the aspergilli were totally absent on the dilution plates even when 1/100 dilution was used. In July, June and May the aspergilli were the maximum in occurrence. Soils when directly plated on the nutrient medium as suggested by Warcup yielded aspergilli indicating that the aspergilli survive the cold season in the mycelial stage. The bio-chemical activities of the soil fungi will be published in a separate paper as the work is still in progress.

31. Effect of Carbon and Nitrogen sources on the production of an antibiotic by *Streptomyces* sp. active against a non-sporulating fungus pathogen.

N. P. SINGH and K. C. BASU CHAUDHURY, Agra.

Singh and Sinha (1962) reported antagonistic affect of a *Streptomyces* sp. on a non-sporulating fungus parasite (Isolate No. Z) causing decay of fruits of *Hibiscus esculentus* Linn. In this paper the effect of different carbon sources (xylose, arabinose, glucose, fructose and lactose) and nitrogen sources (potassium nitrate, ammonium nitrate, alanine, acetamide and urea) on the production of the antibiotic substance by the *Streptomyces* sp. has been presented.

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Among the different carbon sources tested, all were utilized but to varying degrees. Fructose was the best source with an inhibition zone of 4 mm. followed by, in the descending order, glucose (2·6 mm.), arabinose (2·6 mm.), xylose (2·3 mm.) and lactose (2 mm.). Further, an experiment was conducted to see the effect of varying concentrations of fructose viz. 2%, 3·15%, 4%, 6%, 8% and 10% and it was found that the production of the active substance decreased as the sugar concentration was increased from 2% to 10%.

Like carbon sources, the *Streptomyces* sp. utilized the various nitrogen sources giving different results. The inhibition zones formed by different sources are : ammonium nitrate 4·9 mm., potassium nitrate 2·6 mm., alanine 4·3 mm., acetamide 3·5 mm· and urea 2·0 mm.

32. Microorganisms of some Vegetable Surfaces and Tissues and their antagonism.

N. P. SINGH and S. SINHA, Agra.

Simard et al (1958) showed antagonism between some microorganisms isolated from the surface of deal apple leaves and the apple scab fungus, *Venturia inaequalis*. Microorganisms of the surface thus seem to play an important role in the disease relationships of plants. The present investigation of this kind was, therefore, extended to the surface and tissue isolates of some vegetables viz. brinjal (*Solanum melongena*), bottle-gourd (*Lagenaria vulgaris*) and lady's finger (*Hibiscus esculentus*). Among the surface isolates were : 1. *Zygorrhynchus* sp., 2. *Aspergillus* sp. (I), 3. *Aspergillus niger*, 4. *Aspergillus fumigatus*, 5. *Aspergillus tamarii*, 6. *Aspergillus* sp. (II), 7. *Aspergillus sydowi*, 8. *Fusarium* sp., 9. *Monilia* sp., 10. *Cladosporium* sp., 11. *Curvularia* sp., 12. Unsporulating fungus (X), 13. Unsporulating fungus (Y), 14. *Streptomyces* sp., 15. B_1 (Coccoid, Gram −), 16. B_2 (Bacillus, Gram −), 17. B_3 (Coccoid, gram −), 18. B_4 (Coccoid, gram +), 19. B_5 (Spirillum, gram −), 20. B_6 (Coccoid, gram +), 21. B_7 (Coccoid, gram +), 22. B_8 (Bacillus, gram −), 23. B_9 (Coccoid, gram −), 24. B_{10} (Coccoid, gram +). Some of these were obtained exclusively from one type of vegetable, while others were common to two and still a few only isolated from all the three. The isolates causing decay of the vegetables were : two species of *Fusarium* and one non-sporulating fungus. Screening for antagonism among these organisms revealed four positive cases. Further study on the active principles involved in the antagonism forms a piece of separate communication.

33. Spore discharge in *Ganoderma*.

T. SREERAMULU, Waltair.

Although the principles involved in the basidiospore discharge have been described in some detail in recent years, very little is known about the effects of external conditions on basidiospore discharge. No quantitative data are available on the spore discharge in Hymenomycetes. For *Ganoderma*, the heart-rot fungus with hardy perennial bracket-like fruit bodies, it has been shown that spore discharge starts in May and continues until September each year and during these months spore output goes on more or less continuously on a large scale. To provide quantitative data on the rate of spore discharge during these months and to know how external factors like temperature, rain, relative humidity and light determine the day-to-day variations in the rate of spore discharge in *Ganoderma*, continuous quantitative sampling of air near the fruit bodies of this fungus was conducted in June-July in two consecutive years. Hirst's automatic volumetric spore trap with its orifice kept at a height of 35 inches above the ground level

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was employed for air sampling, which was located within 100 yards from the trunk of a tree with three large fruit bodies of *Ganoderma applanatum* growing at about this height. From the data thus collected the diurnal periodicity of spore discharge and how the changes in the spore output are affected by the changes occurring in one or many external factors on different days have been examined. Some of these observations are described in this paper.

On dry days with normal changes in the weather conditions spores of *Ganoderma* are practically absent during the daytime from 08·00 to 16·00 hrs. They begin to appear in small numbers from 18·00 hrs. onwards and within four hours (by 22·00 hrs.) considerable number of these appear in the air. Highest concentrations are encountered during the middle of the night (from 22·00 till 04·00 hrs.) with the daily peak occurring between midnight and 02·00 hrs. These changes recurring regularly on many days suggest the existence of a nocturnal spore discharge mechanism in this fungus. Among the different external factors examined, humidity and rain seem to determine, to a certain extent, the number of spores discharged during the peak hours on any day.

The results obtained under natural conditions are described and discussed and the need for undertaking experimental work under controlled conditions with a view to assessing the role of different factors in determining the diurnal cycle of spore discharge in *Ganoderma* has been pointed out.

34. Leaf-spot of *Eriobotrya Japonica* Lindl.

K. S. THIND and C. L. MADAHAR, Chandigarh.

This paper deals with a new species of *Monochaetia* causing the leaf-spot disease of *Eriobotrya japonica*. It was observed during January to March, 1960, in orchards around Amritsar. The infected leaves are characterized by the presence of isolated, small, round, necrotic areas of brownish to straw colour, up to 7 mm. in length. In severely infected leaves a number of such spots coalesce. Black, dot-like bodies—the acervuli appear on the necrotic areas.

Acervuli : 188-625 × 125-500 μ, distinct, isolated, from 2-3 to a large number on a necrotic area, discoid or cushion-shaped, subcuticular, but later on the cuticle and epidermis cracks above them. Conidiophores hyaline, short, stout, erect, each bearing one spore at the apex. Conidia 20-28 × 7-9 μ, elliptical, 5-6 cells in each spore, 6 being the commonest number, middle four cells of dark brown colour, each being barrel-shaped; both the end cells pointed, hyaline, apical end cell always prolonged distally into a fine, slender, true appendage, sometimes the lower end cell (but only in a spore which is detached from the conidiophore) also projects into an appendage. The latter is the false appendage, being only the broken and stretched left over part of the conidiophore, so the number of appendages is 1-2; appendages 0·7-3 μ long, hyaline, short. Many long, thin, filiform, hyaline paraphyses-like structures are given out from the base of the acervulus, with intermixed conidiophores.

Fungus is easily culturable. It forms a brown pigment and abundant acervuli on P.D.A. Acervuli are reduced in size in culture and occur individually or in groups. Conidiophores and conidia have almost the same size and structure in culture as on the host.

No species of *Monochaetia* is recorded so far on *Eriobotrya japonica*. It does not fit in any known species and is characterized by the profusely developed "paraphyses" in the acervulus. Conidiophores are much less in number and much smaller in size as compared with these. The conidiophores, however, are wider, straight to bent but not flexuous. The "paraphyses", however, are usually flexuous.

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Bryophytes

35. A new report on the occurrence of the moss, *Eurynchium mulleri* (Bry. Jav.) Bartr. in Nilgiri Hills (South India).

C. SRINIVASAN, Annamalainagar.

Ninety five different species of mosses were collected for detailed study from the hills of Kodaikanal and the Nilgiris of South India. Advanced studies of the South Indian mosses in various aspects are progressing well in this laboratory for the past five years. This)plant in question was identified as belonging to *Brachytheciaceae*. When they were sent to a few international authorities for specific determination Professor E. B. Bartram of U.S.A. assures that it is *Eurhynchium mulleri* (Bry. Jav.) Bartr. and adds that it has not been recorded from India before. Fleischer called this plant as *Platyhypnidium mulleri* and included it under *Amblystegiaceae* and Brotherus followed it and referred this species to occur in Java, Sumatra and Luzon.

Therefore, this plant is now reported for the first time to occur in the hills of Kodaikanal in the forest of Priests' Walk at an altitude of about 2300 metres. A brief description of the plant follows :—

This darkish green pleurocarpous moss 3 to 4 c.m. tall, grows creeping on the moist shaded rocks where water is perennially oozing out. It branches profusely and they are erect. The leaves 460 to 484 μ long and 400 to 418 μ broad, are broadly ovate, apex obtuse, upper margin serrulate, midrib extending only up to the lower half and thining out upwards, laminar cells elongated rhombic to linear; seta red elongated, capsule inclined ovoid; peristome 130 to 132 μ × 22 μ at base, operculum arched conical ending in a long stout oblique beak. The axis has a hypodermal rind of thick walled cells. The central strand is absent but it is composed of thin walled parenchymatous cells as is characteristic of the pleurocarpous mosses.

Pteridophytes

36. Studies on the morphology and affinity of the family Parkeriaceae. 1. Morphological observations in *Ceratopteris thalictroides* (L.) Ad. Brongn.

NIRANJAN PAL, Calcutta.

The plants grow free-floating, submerged or on land in the fields, ditches, swamps and wet places and the habit and habitat are largely influenced by these conditions of growth. The size and shape of the successive sterile leaves in a plant are gradually graded leading to an uniform type of highly pinnatisect fertile leaves. Scales occur on the rhizome and young leaf. The latter also bear small glandular hairs.

The rhizome is juvenile plants is protostelic which is gradually transformed into a highly dissected dictyostele with medullary strands in the later-formed regions. The larger peripheral meristeles are arranged in an irregular ring which are intimately related to the irregularly distributed medullary strands. The medullary meristeles of the rhizome have little correlation with those of the stipe. The meristeles are hadrocentric but often assume 'bicollateral' due to profuse anastomosis between the larger meristeles or 'collatral' when they are narrow as in veins. Endodermis and pericycle in rhizome and leaf arise from a common layer of mother cells and are cortical in origin. The endodermis is of the 'primary type'. A feeble cortical mechanical tissue develops round each meristele. The epidermis of the leaf is chlorophyllous. Stomata are present on both surfaces of the sterile

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leaf, on the upper surface of fertile segments and also on the stipe. Mesophyll remains undifferentiated. The primary root originates from a sub-epidermal cell (cortical) of the leaf-base but the secondary root is endodermal in origin. The segmentation, histogenesis and structure of the mature root (though more or less in conformity with other leptosporangiate ferns) are in contradiction with the descriptions provided in the text-books. The endodermis and pericycle have separate origin in root. The root stele is diarch and appear as 'bicollateral' in form.

37. The Gametophyte of *Microsorum Punctatum* (L.) Copel.

NIRANJAN PAL, Calcutta.

Germ tube comes along the linear scar of the spore coat a week after sowing in sterilized soil mixture. First rhizoid appears belated. The germ tube undergoes repeated transvrse divisions and the first vertical wall appears in the terminal or penultimate cell when the filament is 5-9 cells long. By repeated vertical divisions the filament is gradually flattened and a wedge-shaped terminal cell may become differentiated early or at a later period of development. This cell, however, never behaves like a typical apical cell and the diffused type of growth of the gametophyte later becomes localized when an apical marginal meristem is organized. The mature prothallus is cordate and elongated but sometimes nearly ribbon-shaped. Irregularities like unusual elongation of the filament or branching at an early or later period of growth are not infrequent. The prothallus remains one-cell thick except the midrib region. The gametophytes are protandrous, antheridia appearing about one month after germination. Development, structure and position of the sex organs are normal but sometimes some antheridia may be marginal. Rhizoids are brown and they occur in the lower half of the thallus. Unicellular marginal hairs grow sparsely and only at a very late stage of development of the gametophyte. Hairs also occur superficially and these are multicellular, glandular and often branched. Cell-walls of the gametophyte remain thin.

38. Enumeration and distribution of Fern Allies in Eastern India.

G. PANIGRAHI and S. CHOWDHURY, Shillong.

Of the 5 genera and 72 species of non-filicean Pteridophytes in India, this paper presents an enumeration of 45 species of fern. allies belonging to 5 genera (viz. *Psilotum* 1 sp., *Lycopodium* 11 spp., *Selaginella* 30 spp., *Isoetes* 1 sp., *Equisetum* 2 spp.) collected by the Eastern Circle of the Botanical Survey of India from different parts of Eastern India between 1956-1960. Important notes on the habit and habitat of each species, collectors' numbers and localities of occurrence and their relative abundance in the area, are appended to each species. It includes nine species, viz. *Psilotum nudum* (Linn.) Beauv (17522 Geling), *Selaginella intermedia* (Blume) Spring (19419 *Kimin*), *S. pennata* (Don) Spring (17770 Ninguing), *S. pallida* Hook. et Grev.) Spring (19482 Kimin), *S. proniNora* (Lamk.) Baker (4090 Jowai), *S. tenera* (Hook. et Grev.) Spring (3945 Shillong), *S. wallichii* (Hook. et Grev.) Spring (6032 Sissini), *S. wightii* Hieron (7981 Towang), and *Isoetes coromandelina* Linn. (20553 Padmapur) as new records for Eastern India ; eight species, viz. *Selaginella amblyphyla* Alston (3558 Cherrapunji), *S. argentea* (Wall.) Spring (2695 Cherrapunji), *S. atrovirides* (Wall.) Shing (14446 Khela), *S. brachystachya* (Hook. et Grev.) Spring (18981 Digboi), *S. calostachya* (Hook. et Grev.) Alston (14981 Niusa), *S. implexa* (8081 Rahung), *S. peltata* Presl (15310 Baha) and *S. warburghii* Hieron (6950 Bomdila), as new records for India.

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The fern allies, though prolific in the number of species in tropical and sub-tropical forest types, are very rare in temperate altitudes and are completely absent from subalpine and alpine situations. It is significent that *Selaginella wightii* grows on dry bare rock and together with *S. proniflora, S. repanda* and *S. subdiaphana* etc., are more or less xerophytic in nature and rigid and grey in texture. In contrast *S. pentagona*, a native of tropical evergreen forests, grows upto 3 m. and trails through bushes.

39. Pteridaceae in Eastern India.

G. RAGHAVA KUMARI and G. PANIGRAHI, Shillong.

Pteridaceae (Copeland 1947) with 26 genera and 82 species in India is one of the three largest families of Pteridophytes next in abundance to Aspidiaceae and Polypodiaceae in Eastern India. This paper enumerates 18 genera and 55 species collected from different parts of Orissa, Bihar, Assam and N.E.F.A. by the Eastern Circle of the Botanical Survey of India from 1956-1960 with correct names (Panigrahi 1960), furnishes important notes on the habit and habitat of each species with localities of occurrence and abundance and presents in a tabular from the distribution of each species in different types of forests met with in the area (Rao and Panigrahi 1961).

An analysis of the ecogeographical distribution of the species reveals that while 33 species grow luxuriantly in the tropical evergreen and semievergreen forests and 22 species in moist/dry deciduous forests, as many as 42 species flourish in the subtropical)mixed and pine forests either as sun-loving or shade-loving terrestrials. In contrast, only 9 species are found in the tropical riverine forests and 10 species in the subtropical grass lands while another 10 species ascend higher upto temperate altitudes only.

It appears that genera such as *Cibotium, Microlepia, Lindsaea, Sphenomeris, Histiopteris, Cheilanthes, Pityrogramma,* are altogether)absent from temperate altitudes, while *Dennstaedtia appendiculata* and *Anogramma microphylla* are the only two species restricted to temperate situations only. On the otherhand, *Dennstaedtia scabra, Pteris ensiformis, Pteridium aquilinum, coniogramme fraxinea, Aleuritopteris anceps, Onychium japonicum* etc. are widespread species from tropical to temperate forests. But *Microlepia platyphylla, Monachosorum subdigitatum, Hypolepis alpina, Pteris longipes, Cheilanthes hufa* etc. are few of the species restricted to subtropical forests only.

40. Genus *Asplenium* in Eastern India.

G. V. SUBBA RAO and G. PANIGRAHI, Shillong.

Genus *Asplenium* with its 700 species in the world flora is represented in India by 44 species and 13 varieties. This paper presents an enumeration of 29 species of *Asplenium* collected from Orissa, Bihar, Assam and NEFA by the Eastern Circle, Botanical Survey of India between 1956-1960, using correct names (Panigrahi 1960), together with citation of literature and furnishes important notes on the habit and habitat of each species with exact localities of occurrence and abundance in the area. It classifies, in a tabular form, the altitudinal limits to which a species ascecnds and the types of forests in which it flourishes well either as an epiphytic or as terrestrial species, growing on moss-covered tree trunks and branches, in crevices of rocks or in leafy-littered forest floor.

The enumeration includes *A. borneense* (7440 Kimin), *A. paradoxum* (23923, Tumbing, Siang F.D.), *A. perakense* (7539, Chakoo), *A. scortechinii* (7613, Koppu,

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Siang F.D.), *A. spathulinum* (7673, Rupa), *A. subnormale* (7653, Rupa) (cf. Panigrahi 1960) as new records of species for India.

It appears that the genus *Asplenium* is prolific in number of species in the tropical and sub-tropical evergreen/semi-evergreen forests. Although 9 species ascend higher and occur in temperate altitudes the genus is completely absent from subalpine and alpine situations. *Asplenium alternans*, restricted to temperate altitudes, contrasts with *A. perakense* which occurs from the tropics of Orissa to temperate regions of NEFA. It is interesting to observe that *A. borneense, A. finlaysonianum, A. glaucophyllum, A. nidus, A. scortechinii* and *A. spathulinum* growing luxuriantly in the tropical and sub-tropical forests, are absent from the temperate ones, whereas *A. ensiforme, A. griffithianum, A. tenuifolium, A. unilaterale* which thrive well in sub-tropical and temperate forests, seem to be absent from the tropics.

41. *Selaginellas* from the North-East Himalayan Region.

V. THAKUR, Patna.

During a botanical excursion made in October-November, 1958, covering Darjeeling, Kalimpong and some)part of Sikkim, a fairly good number of *Selaginellas* were collected along with other plants. They are given as below :

Name	Locality	Ref. No.
1. *Selaginella adunca*, A Br.	Darjeeling	VT/110
2. *S. biformis*, A. Br.	,,	VT/112
3. *S. barbata* (Kaulf.) Spring. syn. *S. repanda* (Desf.) Spring., syn. *Lycopodium barbatum*, Kaulf.	Gangtok	VT/$\frac{43}{8}$/1958
4. *S. ciliaris* (Retz.) Spring., syn. *Lycopodium ciliare*, Retz.	Kalimpong	VT/$\frac{33}{8}$/1958.
5. *S. delicatula*, Alston.	Darjeeling and Kalimpong	VT/111
6. *S. halferi*, Wart.	Gangtok	VT/114
7. *S. involvens* (Sw.) Spring.	,,	VT/108 & VT/117
8. *S. longipila*, Baker.	Darjeeling	VT/116
9. *S. pentagona*, Spring.	Gangtok	VT/42/1958
10. *S. proniflora*, Baker.	Kalimpong	VT/$\frac{33}{c}$/1958
11. *S. plumosa*, Baker.	Gangtok	VT/113
12. *S. semicordata* (Wall.) Spring.	Gangtok and Darjeeling	VT/109 & VT/115

Many species are common; while others are confined to particular locality. *S. delicatula* collected from Kalimpong was different from one collected at Darjeeling. A herbarium specimen of each of these species has been deposited in the Central National Herbarium, Calcutta.

42. Studies on Indian Hymenophyllaceae. Pt. II. Contributions to our knowledge of *Hymenophyllum simonsianum* Hooker.

MISS USHA SHARMA, Lucknow.

The morphological and anatomical studies of a north Indian Hymenophyllacea, collected from Khasi and Jayantia hills, have been described in this paper. This

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fern is characterised by the presence of roots, which are diarch or triarch. The jet black rhizome is covered all over by one to four celled hairs which are also present all over the leaf on the petiole. The stele is concentric protostele as in *Crepidomanes latealatum.* The leaf trace is concentric at the base and becomes collateral higher up.

The indusium is deeply cleft; the valves being serrate, and the receptacle is elongated but never exserted. The sorus is a simultaneous one.

The sporangia, with oblique and complete annulus numbering eighteen cells, measure 321·0μ × 294·4μ. The tetrahedral spores number ninety four to hundred fourteen and measure 46·6μ × 43·7μ.

43. Studies on Indian Hymenophyllaceae. Pt. III. Contributions to our knowledge of *Meringium edentulum* (v.d.B.) Copel.

Miss USHA SHARMA, Lucknow.

In this paper are described the morphology and anatomy of a Hymenophyllaceous form *Meringium edentulum* collected from Khasi and Jayantia hills of Assam.

The roots are present and are usually diarch or triarch. The thin, jet black rhizome is covered by one to three celled hairs which are very scanty and are absent from petiole. The stele is a mesarch concentric protostele. The pinnately lobed leaf has a stele similar to that of rhizome at the very base but becomes collateral later on.

44. Studies on Indian Hymenophyllaceae. Pt. IV. Contributions to our knowledge of *Mecodiumbadium* Copel.

Miss USHA SHARMA, Lucknow.

The paper deals with the morphology, anatomy, sporangial development and certain stages of cytology of *Mecodium badium,* collected from Khasi and Jayantia hills.

The roots have typical diarch or triarch stele. The rhizome stele is characterised by a double metaxylem band with Mesarch (?) protoxylem.

The pinnately lobed leaf is winged except at the very base. The wings are crisp and are 2·0–2·5 mm wide. The stele in the leaf which is concentric at the very base and collateral a little higher up is shaped, the protoxylem occupying the incurved ends.

The sori number two to twelve on each pinna. The indusium is usually circular and deeply cleft; the clefts approaching the base. The short receptacle is always included. The sorus is almost simultaneous in development as in *Hymenophyllum simonsianum.*

The sporangium measure 488·8μ × 394·8μ and is initiated by a single cell. The annulus is made up of twenty six to twenty seven cells. The spores are circular, tetrahedral and measure 53·48μ.

45. Studies on Indian Hymenophyllaceae. Pt. V. Some developmental stages of the gametophyte of *Mecodium badium* Copel. found within the sporangium.

Miss USHA SHARMA, Lucknow.

Not much is known about the germination of spores inside the sporangium. Even if known the gametophytes have not been observed beyond the three celled stage. In the material of *M. badium* examined, a number of sporangia showed

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stages of germination upto ten celled stage, which is rather unusual. All these different stages have been described and figured.

46. Studies on Indian Hymenophyllaceae. Pt. VI. Contributions to our knowledge of *Crepidomanes bipunctatum* (Poiret) Copel.

MISS USHA SHARMA, Lucknow.

In the present paper, observations on morphology, anatomy sporangial development and cytogenesis of *C. bipunctatum* have been recorded.

As also in *Crepidomanes latealatum*, the roots are absent in this species also. The thick, filiform, and black rhizome is covered all over by unicellular hairs. The stele is concentric. The pinnately lobed leaf is characterised by the presence of submarginal false veinlets unrelated to veins.

The sori are numerous and are present on both the sides of the pinna. The obconic indusium is united below and free above with entire valves. The receptacle is long; included when young but becomes excluded later on. The source is usually gradate and basipetal but certain sori show the old sporangia with younger ones above as well as below. This indicates that the sorus may not always be a strictly gradate one as mentioned by earlier workers. It may on the other hand be sometimes mixed and simultaneous also atleast in some species of the family.

The sporangia, measuring $263\mu \times 235\mu$ have an oblique annulus of 19 to 20 cells, opening by a transverse slit marked by a couple of cells. The sporangium is initiated from a single cell as in the other genera studied so far by the author.

The spore, bearing triradiate mark at its proximal end, has got a large nucleus on one side and measures $48\mu \times 40\mu$.

Gymnosperms

47. Cytology of *Cycas*.

B. V. SHETTY and K. SUBRAMANYAM, Calcutta.

The diploid chromosome numbers in *Cycas beddomei* Dyer, *C. circinnalis* L., and *C. revoluta* Thunb. have been determined to be 22 of which the chromosome number for *C. beddomei* is reported here for the first time. The karyotypes are similar in all the species investigated, except that a pair of heteromorphic chromosomes were observed in *C. circinnalis* and *C. revoluta*. These are presumed to be sex chromosomes, the males being heterogametic and the females homogametic.

Palaeobotany

48. The history of the vegetation of the lower Gangetic plain.

NITYANANDA MALLIK, SALIL KUMAR CHAUDHURI and J. SEN, Calcutta.

The pollen flora of the upper peat horizon below Calcutta has been investigated as part of a programme for studying the history of the vegetation of the lower Gangetic plain. The results of analysis of peat from sections exposed during digging operation near Birati (10 miles N.E. of Calcutta) are described and discussed in this paper.

The peat horizon consists of a lower highly humified layer, a middle moderately humified layer and an upper diffuse layer of peat and clay. Each of these layers is separated by clay. The pollen diagram is revealing. Succession of forests in

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its gross features revals the gradual elimination of arboreous plants, grasses, sedges and ferns, which are present everywhere, specially the former, becoming more dominant. The arboreous forms, e.g., *Phoenix paludosa, Bruguiera parviflora, B. gymnorhiza, Heritiera* sp., etc., and some identificable harbaceous forms are all eliments of a swamp flora, which once thrived in and around the present Calcutta region. This flora has since migrated further southwards and formed (perhaps together with others) the present vegetation of the Sunderbans.

More samples are now being collected and analysed for confirming these preliminary observations. The morphology of spores and pollen of the living vascular plants of the lower Gangetic plain is being studied for making further identification of the microflora in the peat.

The megascopic flora has not been considered in this paper, specially because it is not inconsistent with microflora data.

49. Distribution of plant fossils in the Raniganj Coalfield, Bengal.

SALIL KUMAR CHAUDHURI, NITYANANDA MALLIK and J. SEN, Calcutta.

The paper embodies some results of floristic studies mainly of the Western part of the Raniganj Coalfield. This is part of a more comprehensive work, now in progress, to study the flora of whole of the Raniganj Coalfield.

About 12 species of *Glossopteris,* and 1 species each of *Taeniopteris, Palaeovittaria, Vertebraria, Schizoneura* and *Phyllotheca,* and a number of doubtful specimens and seeds, occur in the successive coal seams of the area under investigations. The relative abundance of these species in different seams, as also in different parts of a single seam, has been worked out. As case of apparent change in the vertical distribution of the flora has been discussed with reference to the known stratigraphy of the area. Megaspores are now being studied as additional tools.

50. Pollen-analytical investigations of the Lower Karewas.

VISHNU-MITTRE, GURDIP SINGH and K. M. S. SAXENA, Lucknow.

From the pollen diagrams recently constructed from the L. Karewa deposits exposed at Sedau, Laredura, Nichahom, Botapathri and Raithan along the North Eastern slope of the Pir Panjal in the SW of Kashmir Valley, the paper describes the vegetational history and the climatic alterations during the early Pleistocene in this region.,The various phases of vegetational development comprise the oak woods, the open pine-mixed woods, the oak-mixed woods, the *Picea*-oak woods and the *Juglans*-elm woods.

During this period when the Lower Karewas were laid, the climate continued to be temperate with the sequence from wet-dry-moist.

The vegetational sequence and the climatic changes are discussed in relation to stratigraphy and finally in the light of these the age of the deposits is determined.

Angiosperms

51. *Morphology of Malpighia Glabra* Linn.

BAHADUR SINGH, Lucknow.

Embryology of *Malpighia glabra,* a rich source of vitamin C, has been worked out to ascertain the possibility of its hydridization as some other Malpighiaceae show only nucellar embryos and no fertilization.

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Microsporogenesis and development of male gametophyte follow the usual course. The tetra-sporic 16 nucleate embryo sac of Penaea type develop sometimes with 15, 14 or even nuclei only.

Pollen tubes are seen in the micropyle. Many embryo sacs degenerate completely. Only polar nuclei of some others survive and their fusion product divides to from endosperm which nurishes nucellar embryos. When egg also survives, only zygotic embryo develops.

The seed coat is formed of both epidermis of the outer integument. Only the inner wall, as well as the radial ones of the inner epidermis, of the inner integument persist separated by an air sac from the testa whose mature cells become lignified and the outer layer develops reticulate thickenings. Only one or two layers of endosperm persist in a seed. The embryo is conduplicate, dicotyledonous and the cotyledons are leafy.

52. The wood anatomy of Meliaceae (Sub-family Cedreloideae).

C. BHASKARARAMA SASTRY, Waltair.

An extensive collection of the wood samples of the different genera belonging to the Meliaceae, was made from different parts of the world. The present communication represents the observations made on the anatomical features of the woods of *Cedrela toona* Roxb., *Cedrela odorata* Linn., *Cedrela Gssilis* Vell., *Cedrela microcarpa., Toona sureni* Merr., *Toona calantas* Merr. & Rolfe., *Chloroxylon swietenia* Dc., and *Ptaeroxylon obliquum* E. Mey of the sub-family Cedreloideae.

The presence of ring porous wood with fairly distinct growth rings, solitary vessels with gummy deposits, perforation plate exclusively simple, intervessel pitting predominantly alternate and medium sized with occasional coalscence of apertures, fibres partly septate and with bordered pits, heterogeneous rays with crystalliferous cells, scanty paratracheal parenchyma along with initial and apotracheal diffuse parenchyma, in strands, with crystals in some of their cells and vertical traumatic gum cavities are characters common to both *Cedrela* and *Toona*. Although *Cedrela* and *Toona* enjoyed separate generic status in the hands of some morphologists, on grounds of wood anatomy *Toona* can be considered as a species of *Cedrela*.

The present study does not lend support for transferring *Cedrela* to Swietenioideae as proposed by Kribs (1930). *Chloroxylon* and *Ptaeroxylon* differ from other genera of the Meliaceae in possessing extremely small vessels, aggregate pores, scanty paratracheal parenchyma, non-septate libriform fibres and rays which are homogeneous and uniseriate in *Ptaeroxylon* and heterogeneous and storied in *Chloroxylon*.

Work on other members of the sub-families, Swietenioideae and Melioideae is in progress.

53. Studies on the structural morphology of pollen grain in the genus *Crotalaria*

P. K. BISWAS and R. M. DATTA, Calcutta.

Pollen grains in *C. juncea, C. usaramoensis* and *C. verrucosa* are 3-colpate. Sexine is thicker than nexine, its surface undulating reticulate with L-O pattern.

Comparative measurements (length at polar axis/breadth at polar axis) and other characters show that *C. juncea* is intermediate between the two other species. Evolution in this genus is of divaricate type, though in one direction as shown by main morphological characters.

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54. The structure and development of ovule and seed of Passiflora foetida Linn.

DALBIR SINGH, Jodhpur.

The paper deals with the investigation of the structure and development of seed of *Passiflora foetida* Linn. Its ovary is tricarpellary, syncarpous and unilocular with parietal placentation. Ovules are anatropous, crassinucellate and bitegmic. Micropyle is formed by both the integuments and it obliquely faces the ovary wall. The vascular supply of the ovule after entering the funiculus travels the raphe and terminates at the chalaza, where it branches forming an inverted umbrella-like structure.

Pollen tube is porogamous and persistent. Occasionally it convolutes inside the embryo sac. Endosperm develops normally in embryo sacs with convoluted persistent pollen tube.

Endosperm development is free nuclear. Enucleate cytoplasmic nodules are observed on the micropylar as well as the chalazal side of the free nuclear endosperm. Finally the enucleate nodules coalesce and this together with the centripetal growth of endosperm cytoplasm results in the filling up of the central vacuole. Wall formation is centripetal and progressive. Enlosperm becomes ruminate or wavy in outline in a mature seed. Embryo development of *Passiflora foetida* conforms the *Myosurus variation* of Onagrad type.

Both the integuments at the mature embryo sac stage are three layered and take part in the construction of seed coat. The epidermal cells of the seed coat are slightly elongated and smoothly cuticularised and those of the middle layer are tangentially elongated. Cells of the inner epidermis of the outer integument are radially elongated and possess starch grains. Inner part of the seed coat originates from the inner integument. Its outer epidermal cells are lignified, radially elongated and form the characteristic sclerenchyma layer of the seed coat. Cells of the middle layer of the inner integument get their inner walls thickened and persist, while those of the inner layer remain small, stain dark with safranin and persist. The seed coat shows ruminations on the flat surfaces of seed.

The mature seed is enveloped in a succulent aril.

55. Studies on the persistent pollen tube of the Cucurbitaceae.

DALBIR SINGH, Jodhpur.

The paper deals with the pollen tube of *Citrullus colocynthis* schrad., *Ctenolepis cerasformis* Naud., *C. garcini* Naud., *Cucumis melo* L. var. *pubescens* Willd., *Cucumis sativus* L., *Cyclanthera pedata* Schrad., *Dicaelospermum ritchiei* Clarke, *Edgaria darjeelinensis* Clarke, *Gymnopetalum cochinchinense* Kurz., *Herpetospermum caudigerum* Wall., *Luffa acutangula* (hermaphrodite var.), *L. graveolens* Roxb., *Melothria maderaspatana* Cogn., *Momordica charantia* Linn., *Sechium edule* S.W., and *Trichosanthes cucumerina* Linn. The pollen tube is porogamous and persistent in all the plants. The course of the pollen tube is straight or sinuous in the nucellus. The persistent pollen tube has a thick wall and scanty cytoplasm. In the ovules of *Cyclanthera, Dicaelospermum, Edgaria, Herpetospermum* and *Melothria* it is observed to dilate in the nucellus. The dilation of the tube does not show any positive correlation with the starch grains of the integuments.

56. A further contribution to the endosperm of the Cucurbitaceae.

DALBIR SINGH, Jodhpur.

The paper deals with the structure and development of the chalazal endosperm haustorium in *Cyclanthera pedata* Schrad., *Dicaelospermum ritchiei* Clarke, *Edgaria*

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darjeelingensis Clarke, *Herpetospermum caudigerum* Wall., *Luffa acutangula* (hermaphrodite var.); and *L. graveolens* Roxb.; and the behaviour of the endosperm nuclei during advanced stages of seed development in *Cucumis sativus* L., *Cucurbita pepo* L., *Cyclanthera pedata* Schrad., *Herpetospermum caudigerum* Wall., S.W. and *Trichosanthes cucumerina* Linn.

The endosperm is free nuclear. It differentiates into an upper vesicular part, the endosperm proper and a narrow tubular chalazal haustorium. Later on, the vesicular part becomes cellular while the chalazal caecum remains coenocytic throughout its life in these plants. In *Dicaelospermum, Edgaria,* and *Herpetospermum* a free nuclear part is, however, left between the narrow caecum and the cellular endosperm. The haustorium remains active up to the heart-shaped stage of the embryo, after which it shrinks and finally disappears. With the decline of the haustorial activity the peripheral cells of the chalazal part of the endosperm proper bulge out. In *Luffa* species these cells divide and form short cellular mounds, the secondary haustoria. It is shown through discussion that the cellular or coenocytic nature of the haustorium depends upon the length attained by it.

The endosperm nuclei during advanced stages of seed development increase in size and become lobed, but in the haustorium of *Cyclanthera* they become vermiform. Simultaneously the nucleoli also acquire different shapes, become vacuolate, and show fragmentation. Deeply staining granular bodies and vacuoles also arise in the nucleoplasm. In *Cucumis sativus* fusion of nuclei is also observed. These are probably the steps leading to the disintegration and final resorptionof of endosperm nuclei by the growing embryo.

The endosperm in the Cucurbitaceae is mostly utilised and in mature seed only one or two peripheral layers are left surrounding the embryo.

57. A contribution to the morphology and embryology of Dicentra scandens Walp.

DALBIR SINGH, Jodhpur and D. S. NEGI, Norman, U.S.A.

The flowers of *Dicentra scandens* Walp. are borne on terminal racemose clusters. Each flower is pale yellow in colour and is subtended by a bract. Its floral parts arise in acropetal succession of two sepals, four petals in two whorls, six stamens forming two groups of three each and a superior bicarpellary, and unilocular pistil with parietal placentation.

The flower receives a branch supply from which the first trace to depart is that of the bract. The bract supply trifurcates after entering it. The remaining cylinder breaks into smaller bundles and, later on, they fuse to form a stellate structure. At this stage from anterior and posterior positions originates the vascular supply to the sepals. Each sepal receives three traces. This is followed by the supply to the outer petals and that of the inner ones in sequence. Each stamen receives three traces, the median which passes to the dithecous anther originates in lateral position, while the other two originate in anterior and posterior positions. They enter the monothecous anthers only higher up after deviating from their place of origin. Thus, the three anthers of one stamen group receive their supply from three diverse sources. The remaining bundles of the cylinder form the carpelly supply.

Ovules are anatropous, bitegmic and crassinucellate. They develop a hypostase below the embryo sac after fertilisation. Vascular supply to the ovule terminates at the chalaza. Development of embryo sac is of Polygonum type.

Microsporogenesis is simultaneous and cytokinesis is by furrowing. Pollen grains are shed at bi-celled stage. They are colpate and triporate. They may germinate *in situ* and rarely while still in tetrads. Frequently branching of the pollen tube is observed.

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Flowers are cleistogamous and protandrous. Germinated pollen grains on the stigma show considerable coiling before entering into the stigmatic tissue. Pollen tube enters the embryo sac through the micropyle and in doing so destroys one of the synergids.

The enlospeerm development is nuclear and the first division of the zygote is transverse. Polyembryony is also recorded.

Seed coat develops from both the integuments. Initially the outer integument is two layered and the inner three cell-layered, except at their tips where the thickness is more. During seed devlopment all the layers disorganise except the outer epidermis of outer integument and the inner epidermis of the inner integument. The cells of the former get cutinised, turns black and form the testa, while those of the latter remain small and thinwalled. The mature seed is albuminous.

On the basis of these studies the nature of the androecium and the systematic position of *Dicentra* in the family is discussed. The androecium is shown to consist of six stamens, diadelphous, two dithecous lateral and four nedian, monothcous and reduced. Reduction of the median stamens is attributed to the developmental pressure. The genus *Dicentra* is considered as least specialised among *Dicentra, Corydalis* and *Fumaria.*

58. Structure and development of ovule and seed of Viola tricolor L. and Ionidium suffruticosum Ging.

DALBIR SINGH, Jodhpur.

Ovules are anatropous, crassinucellate and bitegmic both in *Viola tricolor* and *Ionidium suffruticosum.* Transverse section of an ovary shows that there are many ovules on each placenta in *V. tricolor* while in that of *I. suffruticosum* there are only two ovules on each placenfa. Both integuments of an ovule are two layered to start with but ultimately they become three layered due to the tangential division in the cells of the inner epidermis. In *Viola* cells of the middle layer of outer integument develop tannin. The ovular supply after entering the chalaza fans out in an inverted umbrella-like structure.

The pollen tube enters through the micropyle and is rarely persistent. Double fertilisation is observed in both the plants. One embryo sac of *Viola tricolor* is observed to show reversed polarity.

Endosperm development is free nuclear and wall formation centripetal and progressive. The embryo development follows the Asterad type. Rarely a linear tetrad of proembryo is observed in *V. tricolor....*

Seed coat develops from both the integuments and in its formation only the middle layer of the inner integument disintegrates. All other layers persist and undergo certain changees. Seed epidermis, formed of the outer epidermis of the outer integument, is cuticularised; and its cells in *V. tricolor* have reticulate thickening, while lamellate in *L. suffruticosm.* The cells of the middle layer of the outer integument only persist in both the plants. In *Ionidium* they become thick-walled and elongate at right angles to the cells of the main mechanical layer. The cells of the inner epidermis of the outer integument develops calcium oxalate crystal, one in each cell. and form the third layer of seed coat. Outer epidermis of inner integument forms the main mechanical layer of the seed coat. Its cells are elongated tangentially or along the long axis of the seed. In *V. tricolor* they possess spindle shaped multinucleolate nucleus. They become strongly lignified and have pits on their walls. The cells of the inner epidermis develop cellulose thickening and persist in a mature seed.

The chalazal part of the nucellus develops two hypostase one immediately below the embryo sac and the other in line with the integuments. The cells of the former develop cellulose thickening while that of the latter full of tannin. The

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chalazal cells lying outside the tannin cells of the lower hypostase, later on, become sclerified and join with the lignified cells of the outer epidermis of outer integument, forming a continuous sclerenchyma sheath.

The mature seeds are pear-shaped and possess a hump-like aril of the raphe.

On the basis of embryological and seed coat characters the relationship of Violaceae is discussed with other related families and shown that the seed coat characters provide fresh evidence in favour of Hutchinson's view for putting Violaceae and Resedaceae together.

59. Palynological studies on *Sesbania sesban* Linn (= *S. ægyptiaca* Pers.).

R. M. DATTA and P. K. BISWAS, Calcutta.

Pollen grain is 3-colpate with 3 germ pores, each situated in a colpa almost equidistant from each other. Sexine is thicker than nexine; its surface undulating, reticulate with L-O pattern. No pouting at the Colpi is observed as previously recorded by Datta and Dana (in press) in case of *S. aculeata* and *S. speciosa*. Nexine shows 3 brghtly stained thickenings in the tip regions of 3 germ pores. Comparative measurements show that this species is intermediate between the outer species studied by Datta and Dana previously. Evolution in this genus is of divergent type.

60. Preliminary observations on the rate of pollen tube growth and pollen tube mitosis in *Crotalaria saltiana* (=C. striata).

R. M. DATTA and P. K. BISWAS, Calcutta.

Maximum pollen tube length attained *in vitro* was 980 μ. It continues to grow in culture for 7 hours. 80% of the pollen grains germinated. Callose plugs were observed in a specific type of staining. Its frequency and measurements are noted.

The tube nucleus is found to precede the generative cell, which divides normally with regular equatorial division. No cell plate is discernible in anaphase or telophase. Cytokinesis takes place by furrowing. Two spindle shaped sperms are formed.

61. Pneumatophores in *Cocos Nucifera*

T. A. DAVIS, Calcutta.

Several species of palms manifest certain hydrophytic adaptations. The presence of numerous tiny dull-white outgrowtwhs, each having a perforated head, on the main roots as well as root-lets of palms like the coconut, which help the tips of roots buried deep in the soil under conditions of poor aeration, communicate with the atmosphere for the exchange of gases, is one of them. The rest of the root surface is somewhat impervious to air on account of the hard hypodermal layer. Such short roots which resemble the jasmine bud although vary in size, according to the thickness of the root from which they start, are to be considered as "pneumatophores" or "respiratory roots" and they simulate in function the pneumatophores of *Rhizophora* or *Avicinnia*.

The origin, development, distribution and structure of the breathing root in coconut have been studied. The first breathing root is formed within six months after the germination of the nut has commenced and it it originates like any other root-let. The frequency of the breathing roots gets reduced as their vertical penetration in the soil increases. The structure of the dermal portion of the breathing root differs widely from that of a root-let.

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62. Development of the Seed of *Trianthema portulacastrum* Linn.

V. R. DNYANSAGAR and S. R. MALKHEDE, Amraoti.

The ovule is amphitropous, crassinucellate, bitegmic and is surrounded by 2-layered aril. The mature megagametophyte, a 7-celled structure, consists of a 3-celled egg apparatus, an endosperm mother cell with fused polar nuclei and 3 ephemeral antipodals. Double fertilization occurs within 24 hours after pollination. The endosperm follows the nuclear type of development. The process of cell formation in the endosperm commences from the micropylar end between 6 and 7 days after pollination and then it gradually spreads towards the chalazal end. The endosperm, however, remains free nuclear in the form of a tubular process up to the 11th day after pollination. This process absorbs nutritive materials from the chalazal tissue. No trace of endosperm is left in the mature seed. Embryo development follows the Linum variation of Solanad type. The mature embryo is curved and in its curve there is left a part of the nucellus forming the perisperm. The seed matures 16-17 days after pollination. Its testa is composed of 6 layers, of which 2 belong to the aril, 3 to the outer integument and the innermost represents the inner layer of the inner integument.

63. Gametophytes of *Campynema lineare* Labill. with special reference to its systematic position.

B. S. M. DUTT, Waltair.

The paper deals with the male and female gametophytes of *Campynema,* a monotypic endemic plant occurring in Tasmania.

The anther shows the epidermis, two middle layers, the secretory tapetum and microspore mother cells which divide by successive method. The anthers are extrorse and the pollen grains are 1-sulcate and are shed at two celled stage.

The gynoecium has three free styles.,The numerous anatropous ovules are borne on axile placentae in the tricarpellary trilocular inferior ovary. The hypodermal archesporial cell cuts off a parietal cell and the megaspore tetrads are T-shaped. The embryo sac develops according to the Polygonum type. The micropyle is organised by the inner integument which is wider at the apex.

In the formation of a secretory tapetum as well as a parietal cell in the ovule and the organisation of a micropyle by the inner integument alone, *Campynema* shows a marked departure from the other members of Hypoxidaceae so far investigated. In addition to the embryological features mentioned, the Campynematoideae comprising *Campynema* (distribution : Tasmania) and *Campynemanthe* (distribution : New Caledonia) are characterised by two distinct morphological features, namely, the extrorse nature of the anthers and three free styles and are, therefore, not closely related to the other membrs of the Hypoxidaceae o Hutchinson. It seems best to include *Campynema* under a separate sub-family Campynematoideae under the Amaryllidaceae. A morphological study of its pollen by Erdtman (1952) also lends additional support for such a conclusion.

64. Embryology of *Curculigo crassifolia* Hook. f. with special reference to its systematic position.

B. S. M. Dutt, Waltair.

The archesporium in the anther consists of a plate of three hypodermal archesporial cells. The anther shows the epidermis and four to five parietal layers of which the innermost becomes the amoeboid tapetum. The divisions of the

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microspore mother cells are successive and the pollen tetrads are isobilateral or tetrahedral. The haploid chromosome number is nine. The mature anther consists of the remnants of the epidermis and two hypodermal layers with fibrous thickenings. The pollen grains are shed at the two-celled stage.

The ovules are anatropous, bitegmic and tenuinucellate. The megaspore tetrads are T-shaped. The embryo sac is of the polygonum type. The endosperm is of the helobial type with a smaller chalazal and a much larger micropylar chamber. Free nuclear divisions take place in both the chambers but towards later stages cell wall formation takes place in both the chambers, a feature not so far described in any other member of the Hypoxideae.

The embryo conforms to the Asterad type and keys out to the "Anthericum Variation".

On embryological evidence *Curculigo* can be included under the Hypoxideae.

65 Post-glacial vegetational history of the Kashmir Valley.

GURDIP SINGH, Lucknow.

This paper deals with the pollen-analytical investigations of Post-glacial deposits from four sites namely Toshmaidan, Braman, Walanwar and Damamsar, distributed over the Kashmir Valley slopes of the Pir Panjal Range. The study reveals for the first time the Post-glacial vegetational history of the Kashmir Valley especially in regard to the Post-glacial climatic alterations, biotic influences on vegetational development and the phytogeography of the region.

The entire vegetational sequence is divisible into eight vegetational stages. The forest history began with an open vegetation with conifer woods consisting mainly of blue pine and cedar. During the period of increasing warmth, the wormth and moisture demanding broad-leaved elements such as oaks, alder, birch (*Betula alnoides*), elm, walnut, maple and *Rhus* immigratd. Later, during the period of maximum warmth forests comprising dominantly of the broad-leaved elements established themselves. Afterwards, with the return of colder conditions the conifers reestablished themselves in this region. The conifer woods comprised largely of *Abies* and *Pinus wallichiana*.

Some of the changes in the vegetational sequence are also believed to have been induced by the Prehistoric Man's direct or indirect influence on vegetation. Besides, the evidence of Maize cultivation in the past has also been brought out.

The bearing of this work on the history of some of the mesophytic elements such as oaks, *Alnus* and *Betula alnoides* which are today absent from the Kashmir Valley is also discussed.

66. Growth of embryo fragments of Dendrophthoe falcata (L.f.) Ettings.

B. M. JOHRI and Y. P. SINGH BAJAJ, Delhi.

Johri and Bajaj (1961) reported earlier that the mature embryo of *Dendrophthoe falcata* can be successfully grown on synthetic medium under aseptic conditions. A discoid hold-fast and a pair of leaves develop in about 5 weeks. Fragments of the embryo were grown on modified White's medium containing sucrose (4 per cent), IAA (0·5 ppm) and casein hydrolysate (500 ppm).

The cotyledons alone form a mass of callus which fails to differentiate into a hold-fast and shoot and turns brown in 6 weeks while the radicular portion only, develops a marginal meristem and gives rise to a number of discoid hold-fasts in succession. In the latter case callus may also develop which bears papillate outgrowths. If the plumular region remain intact with the cotyledons or the radicular

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portion normal seedlings with one pair of plumular leaves are produced in 3 to 5 weeks. However, if the central part of the embryo with the plumular portion is grown, it produces a seedling in 3 weeks and the polarity is maintained i.e. hold-fasts develop only from the radicular end. Occasionally callussing may occur at both the cut-ends forming a dumbbell-shaped structure and differentiation into hold-fasts and shoot does not occur. Embryo incised longitudinally only in the radicular portion produces two sets of hold-fasts. If the incision is deeper involving the plumule and half the length of the cotyledons, two seedlings develop which can be separated and grown independently. If the incision divides the embryo into unequal halves, the resulting seedlings are also unequal.

Thus, the plumular region with or without the radicular portion or cotyledons, is capable of producing normal seedlings. Whether the stem tip alone will produce a normal seedling is under investigation.

67. The Structure and Development of Seeds in Convolvulaceae Spomoea Species.

J. S. JOS, Agra.

S. pes-tigridis (Linn.) thrives in waste places during rainy season, while S. reptans (poir) is a hydrophyte. The gynaecium of the pentamerous flower is 3 or 4 chambered, and each loculus contains one or two anatropous ovules which develop from an axile placenta. Ovules are tenuinucellate, unitegmic and the micropyle is formed by the massive integument. The cells of the integument are homogeneous. The nucellus is ephemeral.

The cells of the placenta just around the funicle form an obturator, which occupies the space between the carpeliary wall and the micropylar region of the ovule. The development of the female gametophyte follows the polygonum type and the embryo sac is 8 nucleate. The antipodals, however, disappear very early. The embryo sac during the development of seeds become two lobed.

The first division of the zygote is transverse. The embryo proper is derived from the terminal cell. The embryogeny follows that of the caryophylloid type, Fumaria variation. A few linear embryos are noted where the longitudinal walls have not been laid. The suspensor is very massive. The mature embryo has folded cotyledons. The endosperm is of nuclear type which ultimately becomes cellular.

The seed coat consists of the epidermis, the hypodermis and two or three layers of thick walled palisade sclerenchymatous cells, but in the micropylar region 5 layers of radially stretched cells are present. There are about ten to fifteen layers of palisade cells throughout the integument.

In S. pes-tigridis polyembryony occurs but the origin of multiple embryos could not be traced.

68. Emryological Studies in Gentianaceae. 1. Gentianoideae.

H. MAHESWARI DEVI, Waltair.

The present embryogical investigation of the two sub-families of Gentianaceae, Gentianoideae and Henyanthoideae, was undertaken with a view to examine the bearing of the evidence gathered on the relationships of the two sub-families.

The structure and development of another, pollen ovule, megasporogenesis, female gametophyte, fertilisation endosperm and embryo have been studied in the following representatives of the sub-family gentianoideae.

(1) *Exacum bicolor*, Griseb, (2) *E. Pumilum* Griseb, (3) *E. Petiolare* Roxb., (4) *Canscora Diffusa* R. Br. and (5) *C. Decussata* Roem & Sch.

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The archesporium in the another lobe consists of a plate of 5-10 rows of cells and each row is 6-16 cells deep. Two walls layers occur in *Canscora diffusa C. decussata* and *Exacum pumilum*, three wall layer in *E. Petiolare* and four in *E. bicolor*. Fibrous endothecium is absent in the three species of *Exacum*. In the species of *Canscora* the sub-epidermal layer develops into the fibrous endothecium. The anther tapetum is of the amoeboid type in the two species of *Canscora* and secretory type in the three species of *Exacum*. Small granular thickenings are present on the inner walls of tapetal cells in *Exacum bicolor* and *E. Pumilum*.

Division of pollen mother cells is of simultaneous type. Cytokinesis is by furrowing. Both bilateral and tetrahedral tetrads are formed. The pollen grains are three celled and triporate. The exine shows minute projections.

The ovary is superior and bicarpellary syncarpous. It is unilocular in *Canscora diffusa and C. decussata* and bilocular in the species of *Exacum*. The ovule is unitegmic, tenuinucellate and anatropous.

The primary archesporium is unicellular. A linear tetrad of megaspores is formed. The chalazal megaspore of the tetrad develops into the eight nucleate embryo sac according to the plygonum type. Three uninucleate antipodal cells are formed.

Fertilisation is porogamous. Usually, the pollen grains are monosiphonous, but in about 10% of cases of *C. diffusa*, two pollen tubes are formed per pollen grain.

Endosperm is of the nuclear type. After a few free nuclear divisions wall formation commences from the periphery to the centre ultimately filling the whole embryo sac with cellular tissue. Starch and albumen crystals from the reserve food in the cells of the endosperm.

The terminal cell *ca* alone contributes to the development of the embryo proper and the basal cell *cb* contributes to the formation of the suspensor. This is characteristic feature of the solanad type. Further in the destination of the cells of the tetrad it closely resembles physalis II variation. Thus the embryo development conforms to physalis II variation of solanad type.

The outer epidermis of the integument forms the seed coat.

69. Embryological Studies in Gentianaceae. 2. Menyanthoideae.

H. MAHESWARI DEVI, Waltair.

The present paper deals with the structure and development of anther and pollen, ovary, ovule, megasporogenesis, embryo sac, fertilisation, endosperm, embryo and seed coat in *Limnanathemum indicum* Thw and *L. Cristatum* Griseb.

The archsporium in the anther lobe consists of a plate of 5-10 rows of cells. The anther wall consists of the epidermis, two wall layers, and the tapetum. The sub epidermal layer develops into the fibrous endothecium. The tapetum is of the secretary type. Nuclear divisions and fusions of tapetal cells are seen. Division of pollen mother cells is of simultaneous type. Cytokinesis is by furrowing. Both bilateral and tetrahedral tetrads are formed. The pollen grains are three celled and triporate. The exine shows rod like thickenings in it.

The ovary is superior, bicarpellary syncarpous and unilocular with two to four parietal placentas. The ovule is unitegmic, temuinucellate and anatropous. An integumentary tapetum has been differentiated in both the species.

In one case of *L. cristatum*, fused ovule has been observed.

The primary archesporium is unicellular. A linear tetrad of megaspores is formed. The chalazal megaspore of the tetrad develops into the eight nucleate embryo sac. Three uninucleate antipodal cells are formed.

Fertilisation is porogamous.

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Endosperm is of the cellular type. The cells of the endosperm are filled with protein bodies as reserve food.

Embryo development keys out to the senecio variation of Asterad type in both the species studied.

In *Limnanthemum indicum*, in one case, however, two embryos were seen in addition to the zygotic embryo. Judging from their position, they seem to be developed from the two synergids.

The outer epidermis of the integument forms the seed coat.

On the basis of morphological, anatomical (both vegetative and floral) and embryological characters, the two sub-families, Gentianoideae and Menyanthoideae of the family Gentianaceae, may be raised to the rank of independent families namely, the Gentianaceae and Menyanthaceae.

70. Replacement of Inflorescence by Turions in Aponogeton crispum Thunb.

H. P. MEHTA, Varanasi.

Aponogeton crispum Thumb. is a common aquatic plant of the ponds of Varanasi. It is a scapigerous freshwater herb with tuberous root stock. In the month of August as the ponds are filled up, it starts flowering. The scape is cylindrical and smooth. Its length varies with the depth of water. The spike is 5 to 12 cm. long, simple, solitary and densely flowered. All the leaves, which are membraneous remain submerged and only the spike projects out of the water. By the end of November the water level in these temporary ponds falls gradually when fruit formation starts. In one of the ponds, as the water level fell, floating leaves which are not membraneous as the submerged ones developed. In these plants some of the scapes were obsrved to bear a turion in the place of inflorescence. The turion proliferates giving rise to two, three or more leaves with long petiols, which are all floating ones. The turions are bulb-shaped.

The study of relation existing between the turions and the inflorescence and the factors involved in the production of turions are of interest.

Ecological conditions under which the plants were growing are given and further study regarding the nature and factors, is in progress.

71. Embryology of Plantago coronopus Linn.

R. C. MISRA, Lucknow.

Plantago coronopus flowers arise on a long spike. The are bisexual, actinomorphic and tetramerous. The ovary is bicarpellary and syncarpous. In each locule of the carpel two, unitegmic, anatropus, ovules arise on an axile placenta. One or two archesporial cells differentiate in an ovule, but only one functions ultimately to become directly a megaspore mother cell. The embryosac development is of the 'Polygonum type'.

After double fertilization, the primary endosperm nucleus divides and the daughter nuclei are separated by a transverse wall to form two cells. The chalazal cell becomes binucleate and functions as the endosperm haustorium. The micropylar cell undergoes two divisions to form four cells. The first division is longitudinal while the second is transverse. The upper two cells function as micropylar haustoria and the remaining two, by series of divisions, from the endosperm proper. The haustoria grow to reach the placenta. The embryogeny conforms to the Onagrad type.

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72. Leaf structures in grasses.

B. N. MULAY, B. D. DESHPANDE and Miss N. LALITHA Pilani.

(i) Leaf anatomy of the following grasses was investigated : Subfamily Pooideae :—

1. *Arundo donax* L. 2. *Eragrostis tremula* Hochst 3. *Dactyloctenium aegyptiacum* L. 4. *Desmostachya bipinnata* Stapf. 5. *Aristida mutabilis* Trin and Rup. 6. *Tragus biflorus* Schultz. 7. *Perotis indica* O. Ktze. Subfamily Panicoideae :—8. *Cymbopogon parkerii* Stapf. 9. *Erianthus munja* O. Ktze. 10. *Brachiaria ramosa* Stapf. 11. *Panicum antidotale* Retz. 12. *Digitaria adscendens* (HBK.) Hener. 13. *Cenchrus ciliaris* L. 14. *C. barbatus* Schum 15. *C. preuri* Kunth 16. *Setaria verticillata Beauv.*

(ii) Following taxonomic criteria were used for classification :

1. Presence or absence or ill-developed midrib region. 2. Occurrence and arrangement of bulliform cells. 3. Single or double bundle sheath, with or without chloroplasts. 4. Nature of sheath cells. 5. Arrangement of chlorenchyma, whether regular in radial bands, or irregular or all around the bundles.

(iii) Based upon the above criteria the following groups are recognised : Subfamily Pooideae :—without prominent midrib region.

1. Arundinoid type. 2. Eragrostoid type. 3. Aristidoid type. 4. Chloridoid type. Subfamily Panicoideae :—with prominent midrib region. 5. Panicoid type. 6. Andropogoneae type. 7. Sacchariferae type.

(iv) The authors recognise the types suggested by Brown (1958) but do not agree with him for inclusion of tribes Eragrosteae and Zoysieaein "Chloridoid" type and so a type "Eragrostoid" is suggested. Authors would suggest that type Panicoid" may be restricted only to the genera *Panicum* and *Brachiaria* because they differ considerably from other grasses in their leaf structure.

73. Lateral bud development and flowering of branches in teak *(Tectona grandis* L.F.) in relation to light.

K. K. NANDA, Dehra Dun.

This paper deals with observations on the branching behaviour and flowering of the main shoot and branches of teak.

The flowering of the main shoot as well as branches is terminal. In close stands flowering occurs only in don inant and co-dominant trees and is confined to the upper parts which are exposed to bright sunlight. There are no inflorescences either on the lower parts of these trees or on those which grow under a thick canopy. Flowering is profuse on all sides in trees which are growing singly. As against this in trees growing on the border of thick stands flowering is confined to the lighted side and is more or less completely absent on the shaded side. These differences in growth and flowering are ascribed to the differences in the intensity of likht to which these plants are exposed while growing in different situations. It is shown that the curtailment of light delays not only the initiation of flower buds but also their development into flowers as well as in the production and ripening of fruits.

The emergence of branches and their flowering appears to be controlled by factors which are related to ageing or completion of the main shoot or the branch on which these are produced. The first branch emerges from the node immediately below the previous years inflorescence and the second one from the node next below it and so on. The flowering of these branches also follows the same order. The basipetal sequence in the emergence and flowering is exhibited even by secondary tertiary, quarternary and further branches.

The results are discussed in the light of branching and flowering behaviour of other plants.

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74. Embryological studies in *Acalypha alnifolia* Klein ex Willd.

PIRATLA NARASIMHA RAO, Waltair.

The paper deals with the microsporogenesis, male gametophyte, structure of the ovary, ovule and embryosac in *Acalypha alnifolia*.

The wall of the anther consists of the epidermis, fibrous endothecium, single middle layer and tapetum. Tapetum is of the secretory type. Divisions of the microsporemother cells are simultaneous. Cytokinesis takes place by furrowing. Microspore tetrads are tetrahedral or decussate. The mature pollen grains show three or four germ pores and are shed at the thee celled stage.

The ovules are anatropous, bitegmic and crassinucellate. The obturator arises from the placenta and extends into the micropyle. The embryosac is tetrasporic and sixteen nucleate. The organization of the matcre embryosac is of the modified Penaea type and is similar to that of *Acalypha indica* (Maheswari & Johri, 1941).

75. On the development of endosperm and embryo in *Lindenbergia indica* (Linn.) Kuntze.

NIRANJAN PAL, Calcutta.

The first division in the endosperm is transverse followed by a vertical division in the micropylar chamber. This vertical wall is laid down only at the end on the transverse wall. Then these two cells divide again in the transverse direction separating two cells in the middle tier and two free nuclei at the micropylar end. These two free nuclei divide once and a four-nucleate micropylar haustorium differentiates. The chalazal chamber, on the contrary directly functions as the chalazal haustorium. The middle tier of two cells gives rise to the proper endosperm tissue. The cells of the endosperm at the micropyylar end form the isthmus and function as a conductive and nutritive tissue. Those cells lying at the chalazal end, on the other hand, do not show any specialization. The peripheral cells in the endosperm, at a later stage of development become active and digest the surrounding tissues. The mature seed contains only two layers of endosperm.

Before the occurrence of the transverse division, the zygote elongates enormously. The basal cell *cb* divides twice in succession forming cells *d* (which acts as the hypophysial cell), *f*, *n* and *n'*. The terminal cell *ca* undergoes two successive vertical divisions followed by a transverse division in each of these cells. Thus an octant in two tiers is derived. Next division in each of the octant cells is periclinal. Cells from both tiers *i* and *l'* contribute in the formation of the cotyledons.

76. The development and structure of the endosperm and embryo in *Mazus japonicus* (Thumb.) Kuntze.

NIRANJAN PAL, Calcutta.

The first division in the endosperm is transverse, the chalazal cell divides vertically and these two cells constitute the chalazal haustorium. Later, this is transformed into a two-nucleated cell. The micropylar chamber is subjected to a longitudinal division followed by the formation of a transverse wall in each of the daughter cells and the two cells in the micropylar tier differentiates into the micropylar haustorium which also later become single-celled. The two nuclei become hypertrophied and the haustorium develops tubular branches which grow towards the chalaza. The two cells in the middle tier undergo two successive transverse divisions followed by divisions in all directions and gives rise to the

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proper endosperm tissue. The endosperm cells at the micropylar end are conductive and lie in a narrow zone forming an isthmus. After the precoceous. disorganization of chalazal haustorium, the endosperm cells at the chalazal end form a complex multinucleate amoeboid mass of protoplasm which also functions as a conductive organ. At a later period of growth, the peripheral cells of the endosperm become organized into a digestive tissue. Mature seed contains two layers of endosperm cells.

The zygote attains a great length prior to a transverse division. The terminal cell *ca* undergoes two successive vertical divisions at right angle to each other followed by a transverse division in each of these cells resulting in the formation of a terminal octant in two tiers. Then periclinal divisions occur in these cells. The cotyledons of the embryo are contributed by both tiers *l* and *l'*. The basal cell *cb* divides transversely twice in succession when cells *d* (which is the hypophysial cell), *f*, *n* and *n'* are derived.

77. A contribution to the Embryology of Combretaceae.

P. S. PRAKASA RAO, Waltair.

The present paper deals with microsporogenesis, male gametophyte, megasporogenesis and female gametophyte of *Terminalia catappa* Linn., *Combretum decandrum* Roxb. and *C. ovalifolium* Roxb.

There are ten stamens in two whols of five each. The anther consists of the epidermis, the fibrous endothecium and three to four middle layers of which the innermost forms the secretary tapetum. The tapetal cells become two nucleate. The divisions of the microspore mother cells are simultaneous and cytokinesis is by furrowing. The pollen tetrads are isobilateral and tetrahedral. The pollen grains are shed at two-celled stage.

The unilocular ovary is inferior and contains two to three pendulous, anatropous and bitegmic ovules. The archesporial cell cuts off parietal cell. The megaspore mother cell undergoes the two meiotic divisions resulting in a linear tetrad of megaspores of which the chalazal is functional. The embryo-sac development is of Polygonum type. The antipodal cells are ephemeral.

The funicular obturator is present in both the species of *Combretum* while it is absent in *Terminalia catappa*.

Work on other members of Combretaceae is in progress.

78. Studies in pollengrain germination of certain plants of Malvaceae and related families in vitro.

S. S. PRASAD, Muzaffarpur.

Pollen grains of *Hibiscus vitifolius* L., *Hibiscus esculentus* L., *Hibiscus mutabilis* L., *Hibiscus rosasinensis* L., *Sida spinosa* L., *Abutilon indicum* G. Don., *Malachra capitata* L., *Althaea rosea* L., *Bombax malabaricum* DC. and *Grewia asiatica* L. were collected soon after anthesis and dusted on slides smeared with sucrose-agar-gelatin medium. The laboratory temperature varied between 26° and 27° centigrade. The pollen grains began to germinate within ten minutes of dusting. The growth was very rapid during the first half an hour after dusting. After thirty minutes the growth slowed down and at the end of an hour practically it ceased. Out of ten species of plants chosen for study, the pollen grains of only five germinated while those of the rest did not respond in vitro. Such species proved obstinate and even ·01% Boric acid and higher percentage of sucrose solutions failed to induce germination of their pollen grains.

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The results of the observations are tabulated below :

Name of species.	Percentage of germination.	Type of germination.	Longest tube observed.
Hibiscus citifolius L.	95%	Polysiphonous, no branching, up to 12 tubes observed emerging out of a single pollengrain.	173·60 μ
Hibiscus esculentus L.	94%	Polysiphonous, tubes profusely branched.	1557·00 μ
Hibiscus mutabilis L.	20%	Polysiphonous, no branching.	86·80 μ
Hibiscus rosasinensis L.	No germination	——	——
Sida spinosa L.	40%	Monosiphonous, no branching.	43·40 μ
Abutilon indicum G.Don.	4%	Monosiphonous, no branching.	41·30 μ
Malachra capitata L.	No germination	——	——
Althaea rosea L.	No germination	——	——
Bombax malabaricum DC.	——	——	——
Grewia asiatica L.	——	——	——

Thus we find that pollengrains of some of the species germinated readily while those of others proved obstinate in vitro. In the species of *Hibiscus* polysiphonous tubes are observed but branching is seen only in *Hibiscus esculentus L.* Species of *Sida* and *Abutilon* produce unbranched monosiphonous tubes. Work on the effect of amino-acids, sugars and vitamins on germination of pollengrains is in progress.

79. Palynological investigation of Cucurbitaceae (Part II).

MISS PRITI AWASTHI, Lucknow.

Present study is a further contribution to our knowledge of pollen morphology of Cucurbitaceae plants. Eighteen species and their varieties belonging to the following 12 genera have been studied and their palynograms described. *Actinostemma tenerum, Blastania garcinii, Citrullus vulgaris, Citrullus vulgaris* var *fistulosus, Coccinia indica, Cucumis melo* var *utilissimus, C. sativus, C. trigonus, Gompogyne cissiformis, Leginaria vulgaris* (round fruited variety), *L. vulgaris* (long fruited variety), *Luffa acutangula, L. cylindrica Monordica balsamia, M. Charantia, M. dioica Mukia scabralla, Trichosanthe cuccumeria, T. dioica* and *Zehneria umbellata.* Abnormalities have been observed in the pollen of cultivated species, these include increase in the number of apertures and the syncolpate conditions. It has been found that the general morphological pattern of the species varies slightly from variety to variety. At the same time the percentage of abnormalities also varies from variety to variety. The full significance of this is being studied.

80. On the morphology of the pollen grains of two species of Cucurbita, L.

MISS PRITI AWASTHI, Lucknow.

The present communication, pollen morphology of two species of *Cucurbita* namely *C. pepo* and *C. Moschata* is presented. Fresh material were collected from

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the vegetable farm of the Agricultural College (Kanpur), and slides were prepared according to the acetolysis method recommended by Nair (1960), in which acetolysed pollen grains were mixed with safranin stained unacetolysed ones. During the morphological observations, percentages have been taken of (i) size variations, (ii) grains with various excrescences types, (iii) abnormal grains, (iv) sterile grains. "Giant grains" with the size of 304 μ have also been found rather unusual among angiosperms. A large range of size variation is perhaps pointer to the polyploid nature of the species. Grains are panporate and spinate. Pollen grains of *C. pepo* do not show such a great variation in pollen morphology as *C. Moschata*. Grains of *C. pepo* are characterised by having smaller number of pores than those of *C. moschata*, and spines with acute tips.

81. Studies in the Seedling Anatomy of *Mirabilis jalapa* L.

RAMJI SHARMA, DHAR M. P. and (MISS) MALTI PATHAK, Indore.

The shoot apex has a three layered tunica, the second layer of which initiates leaf primordium. Each primordium differentiates an arc of meristem that extends basipetaly in the stem and the two arcs descending from the two opposite leaf primordia meet together to form a continuous ring of residual meristem. Procambial strands are differentiated from this tissue : three in each leaf, and all the six strands of leaf pair at each node descend directly in the internode below, connected together by the residual meristem ring. In the internode region too, the residual meristem differentiates new procambial strands that mature into normal collateral, endarch bundles. The residual meristem, soon after, begins to produce parenchyma inwardly so that the newly formed bundles get separated centrally from the meristematic ring. This also applies to foliar traces which are the first to separate. Foliar traces have a course as described by De Bary (1884). In the hypocotyl, four bundles with alternating protoxylem groups are seen : the two protoxylem groups in the cotyledonary plane are directly descended from the cotyledons, while those in the inter-cotyledonary plane are formed afresh. This tetrarch condition becomes diarch lower below due to fading away of the protoxylem groups in the intercotyledonary plane.

82. Studies in the Embryology of *Canscora diffusa* L.

RAMJI SHARMA, DHAR and S. R. UPADHYAY, Neemuch.

The microsporangium differentiates from a five layered meristematic zone in each anther lobe. The anther wall consists of an epidermis, an endothecial layer, a single wall layer and a glandular tapetum surrounding the sporogenous mass. The tapetum, at the mother cell stage, becomes amoeboid and invades the microsporangial cavity. The microspores are spherical, tricolpate and porate.

The unitegmic, tenuinucellate, anatropous ovule differentiates a single (rarely two) hypodermal archesporium which directly functions as the megaspore mother cell. The development of the embryo-sac is monosporic, Polygonum-type. The three antipodal nuclei are extremely ephemeral : a character shared by the Menyanthoideaë. Fertilization is normal. The endosperm is free nuclear till the bi-celled stage of the pro-embryo.

The embryo development has been traced in detail and it corresponds with the Sagina variation of Caryophylloid type. This type of embryo development is found in the Menyanthoideae. It appears that in embryological features too, *Canscora* combines in it the characters of Gentianoideae as also of Menyanthoideae and hence the integrity of a single family Gentianoideae has been emphasized.

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83. Studies in the Floral Anatomy of *Canscora diffusa* L.

RAMJI SHARMA, DHAR and S. R. UPADHYAY, Neemuch.

The tetramerous flower receives four calyx traces in pairs that soon divide into three each. Higher up, four traces to the corolla and another alternating four to the stamen depart to a common corolla tube. Later, the stamen traces trifurcate; the two laterals entering the corolla as corolla laterals, while the median one supplies the stamen. The two carpels receive only one dorsal trace each; the ventrals are apparently absent. The dorsals run through the whole length of the ovary and continue up in the style. In the ovary, horizontal branches of procambial nature are given off from the dorsals and these branches supply the placentae. Two collenchyma strands are seen running along the fused margins of the carpels, and these simulate fused ventrals. The parietal placentae arise as sub-marginal outgrowths and each bears anatropous ovules along three vertical rows. The fusion of corolla laterals with the staminal traces and the absence of ventrals point to a high degree of floral evolution in this species. The condition of fused corolla laterals with the staminal traces is found in the Menyanthoideae only and it is suggested that *Canscora* combines in it characters of Gentianoideae and Menyanthoideae both. Hence retention of a single family Gentianaceae has been advocated.

84. Foliar Sclereids of Dendropthoea falcata.

A. R. RAO and MANJU MALAVIYA, (Miss), Lucknow.

Although the occurrence and distribution of the foliar sclereids of this genus have been studied by Rao, T. A. and S. S. Kelkar (Journal of the University of Bombay, Vol. XX, part 3, November 1951), their ontogeny was not known. A study of the ontogenetic development of these sclereids is mentioned in this paper.

The sclereids are transformed parenchyma cells which differentiate into sclereid initials mostly near the vascular bundles of the petiole. The differentiation gradually spreads into the lamina, towards the margin and the lower and upper epidermis. The sclereid initial may be solitary or in groups. They loose the cell contents, the wall becomes stratified and protrudes as a tubular or spiny growth in the surrounding intercellular space giving even the very young sclereid a stallate appearance. Further stratification of the wall is accompanied by pitting, the pits being thick, narrow and slit like. Further stratification closes these pores and the fully adult sclereid does not show any pores, and can be placed under the section Asterosclereid of Foster and also Esau. Generally there is a solitary crystal in the lumen of the adult sclereid, often embeded in the wall. The crystal disappears after heating it with NaOH. Further observations on these sclereids in the floral parts are in progress.

85. Embryology of *Lagotis glauca* Gaertn. (Selaginaceae).

M. A. RAU and V. K. SHARMA, Dehra Dun.

The family, Selaginaceae is as yet embryologically uninvestigated. Its systematic position and relationships are of interest since taxonomists have differed in their treatment of the family. Bentham and Hooker placed the Selagineae (including Globulariaceae) near the Verbenaceae. Engler and Prantl, while recognising the Globulariaceae as a separate family, treated the Selagineae as a tribe under the Scrophulariaceae. In recent years, Hutchinson has included the Selaginaceae in the order Lamiales.

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Lagotis glauca, investigated here under a CSIR scheme on the morphology and embryology of some families and genera of disputed systematic position, is a herb found in the alpine zone of Western Himalayas. Material for study was collected from plants growing at an altitude of 4000 metres. The blue zygomorphic flowers are in dense spikes. The ovary is two locular with a single pendulous ovule in each locule. The ovules are anatropous, unitegmic and tenjinucellate. Megasporogenesis results in a linear tetrad of megaspores. Development of embryosac is of Polygonum type. Endosperm is cellular and the micropylar and chalazal haustoria are weakly developed. Embryo development conforms to Onagrad type and is placed in the first group, fourth megarchetype of the first period in the system of classification of Soueges.

86. The floral anatomy of Woodfordia floribunda Salisb.

V. S. RAO, Bombay.

The vascular anatomy of the flowers of *Woodfordia floribunda* Salisb is studied. The floral tube is supplied by 12 bundles which arise at the same level. The androecium is supplied by 12 bundles which arise in positions opposite the perianth traces. Certain interesting features in the anatomy of the gynoecium are described.

87. Morphological differentiation of the section Sativa of the genus *Oryza*.

S. D. SHARMA and S. V. S. SHASTRY, New Delhi.

The present views on the phylesis of *Oryza* emphasize that *O. perennis* of the section Sativa is the most primitive species and that the other section, Officinalis and Granulata are of later origin. The morphological comparison of *O. perennis*, *O. spontanea*, *O. sativa* and *O. officinalis* indicate that for the chracters—breadth of the leaf, congestion of the branches on the panicle, number of secondary branches on the main branches and flattening of the caryopsis—*O. perennis* and *O. officinalis* occupy extreme positions. This could mean either that *O. officinalis* is a donor for introgression into *O. perennis* thereby leading to the origin of *O. sativa* or that a freely hybridizing pre-Sativa and pre-Officinalis group existed in the past which combined the characters of the species *O. perennis* and *O. officinalis* into what has subsequently evolved into *O. sativa*. The morphological date indicate that the role of *O. officinalis* in the origin of cultivated rices cannot be discarded, but needs further investigation.

88. Variation in length of vessel elements and libriform fibres within one tree Ulmus procera Salisb.

B. S. SIVA RAO and N. VIJAYALAKSHMI, Waltair.

In view of the comparative lack of definite information regarding the variation in length of the vertical elements of the secondary xylem in the individual angiosperm trees, variation in length of libriform fibres and vessel-elements was investigated in a ring porous Elm (*Ulmus procera* Salisb.) in successive growth rings from pith outwards, in specific growth rings from base upwards and between the early and late wood within one ring in the bole. Increase in length of these elements was noticed to be rapid at first and afterwards rather slow at any one level from pith outwards in the successive growth rings at four different levels in the bole. This increas in length was gradual nearer the base of the bole whereas

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it is abrupt higher up. In the specific growth rings there was a gradual increase in length of these elements from base upwards in the bole upto certain height after which the length decreased. The first-formed early wood elements of a growth ring are distinctly shorter than those of the last-formed elements. An abrupt fall in length of these elements was noticed in the transition from late wood of one ring to the early wood of the succeeding ring.

89. Embryo development of Mollugo L.

B. S. SIVA RAO, Waltair.

A detailed development of embryo has been studied in five species of *Mollugo* (*M. oppositihfolia* L., *M. nudicaulis* L., *M. cerviana* Ser., *M. distichi* Ser., and *M. lotoides* O. Kze.). The first division of the zygote in transverse forming two superposed cells *ca* and *cb*. Cells *ca* and *cb* divide transversely giving rise to four cells *l*, *l'*, *m* and *ci*. *l'* divides in a transverse plane giving rise to *ph* and *h*. *h* divides giving rise to *ha* and *hb*. The cells *m* and *ci* divide and give rise to a number of cells, *d*, *f*, *n*, *o* and *p* which form the suspensor.

The derivatives of the terminal cell of the two-celled proembryo contribute to the formation of the embryo proper while the suspensor is formed by those of the lower cell.

The formation of the embryo entirely from the derivatives of the two-celled proembryo, the presence of a hypophyseal initial and the formation of a linear suspensor which is not haustorial, key out to the Linum variation of Solanad type.

90. Structure of the secondary xylem of some dicotyledonous trees.

B. S. SIVA RAO, Waltair.

In view of the fact that wood from different parts of individual tree is extremely variable, an intensive rather than extensive study of the structure of secondary xylem has been undertaken in the bole, branch and root in oak (*Quercus robur* L.), beech (*Fagus Sylvatica* L.), sycomore (*Acer pseudoplatanus* L.), and robinia (*Robinia pseudoacacia* L.), Length variations of the vertical elements of wood (vesselelements, libriform fibres, fibre tracheids and tracheids), were studied from different positions of the same organ and from different organs in each of these trees. Histological features of the secondary xylem were studied in detail in respect of the ring and diffuse porous nature of the wood, size and structure of the vessel—elements the intervascular pitting, perforation plates, the nature and distribution of radial and vertical parenchyma. Differences in structure of the vertical elements of wood and the nature of variability in length of these elements in the boles, branches and roots in these trees, were brought out.

91. A contribution to the family Zygophyllaceae.
I. Development of male and female gametophytes of *Fagonia cretica* L.

R. D. SHUKLA, Udaipur.

The family Zygophyllaceae has received very little attention from the morphologists. Previous knowledge on the floral morphology of this family is not in a satisfactory state. Floral morphology and gametophytes of *Fagonia cretica* L. which is of common occurrence on rocky and hard soil in the State, flowering throughout the year, profusely after rains, have been described. Tricolpate pollen grains with smooth exine and intine are shed at tricelled stage. At unicelled

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stage it exhibits darkly stained chromatin like particles. There are two collateral obliquely anatropus ovules in each loculus. A well developed integumentary tapetum is present. Nucellus is scanty and ephemeral. A well developed lignified hypostase is differentiated. The development of the embryo sac is monosporic and its organisation conforms to that of Polygonum type. Further work on the other members of the family is in progress.

92. Structure and development of seeds in Euphorbiaceae : *Phyllanthus niruri* L.

R. P. SINGH, Agra.

The bitegmic ovule is nearly hemianatropous. The nucellus is massive; its knob-shaped beak extends beyond the integuments and comes in contact with the cells of obturator. The inner integument is generally three cell-layers thick while the outer integument is two cell-layered. The arrangement of the inner epidermal cells of the outer integument is very characteristic as the cells are arranged in two different patterns.

A hypostase is distinguishable at the base of the nucellus in post-fertilisation stages. It is composed of thick-walled cells and persists in a mature seed.

The seed-coat is formed by both the integuments. The cells of the outer epidermis of the outer integument elongate considerably during seed-development. In a mature seed they are arranged loosely and have a characteristic shape. The cells of the inner epidermis of this integument also persist in a mature seed and give a characteristic appearance under a stereoscopic binocular. The cells of the outer epidermis of the inner integument form the characteristic sclereid layer of the seed-coat. The embryo is of the Spatulate type and is slightly curved. The seeds of *Phyllanthus niruri* are excarunculate.

93. Structure and development of seeds in Euphorbiaceae : *Putranjiva r o xburgh* Wall.

R. P. SINGH, Agra.

The superior ovary is generally trilocular. Each loculus possesses two collateral, pendulous and anatropous ovules. The nucellus at the time of fertilisation persists only as a column of cells at the base of the embryo sac. The inner integument, at this stage, is composed of 7 to 10 layers of cells. The cells of the inner epidermis of this integument are tapetum-like. The micropyle, except at the top, becomes imperceptible owing to the growth of the inner integument. The outer integument is composed of 4 to 7 layers of cell, but in the region of the raphe the number is larger. The vascular strands are present in this integument. These strands are the ramifications of the raphe bundle.

The development of the endosperm is of the free nuclear type and the endosperm ultimately becomes cellular. The mature embryo is of the Spatulate type. A hypostase is differentiated during seed-development. It consists of sclereids. The integumentary tapetum owing to divisions in various planes from a number of bulges at various places. These bulges face the embryo sac and majority of them are absorbed by the growing endosperm although, at places they are well-marked even in a mature seed.

The seed-coat is formed by both the integuments. The outer epidermal cells of the inner integument form the characteristic layer of the seed coat. The seeds of *Putranjiva roxburghii* are excarunculate.

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94. Structure and development of seeds in Euphorbiaceae : *Bischofia javanica* Blume.

R. P. SINGH, Agra.

The superior ovary is generally trilocular. Each loculus has two collateral, pendulous and anatropous ovules. The micropyle is formed by both the integuments. The nucellus is massive and its small beak reaches the base of the narrowly enlongated endostome. The inner integument is 3 to 5 cell-layers thick. The outer integument is composed of 2 to 3 layers of cells but along the raphe and in the basal region the number is larger.

The development of the endosperm is of the Nuclear type. A hypostase differentiates at the base of the nucellus. Its cells become thick-walled and form a firm tissue at the basal region of a seed. A narrow zone of perisperm also persists above the hypostase.

The seed-coat is formed by both the integuments. The cells of the outer epidermis of the inner integument form a characteristic sclereid layer of the seed-coat. The other layers which persist are, the intermediary layer and the inner epidermis of the inner integument, and the outer and inner epidermal layers of the outer integument. The middly layer or layers of the outer integument are also discernible in a seed. The embryo is of the Spatulate type. The seeds of this plant are excarunculate.

95. Histochemical Studies on the Nectaries of *Sesamum indicum* L.

S. P. SINGH, Agra.

There are two laterally placed nectaries on the pedicel of the flower. On the basis of organogeny and the vasculate, the nectaries are found to be floral buds arrested in growth, and modified to serve the function of secretion. Histochemical studies were undertaken to determine the nature of secretion and a beginning was made with the test for the localization of acid phophatse in the nectaries. Nearly whole of the nectary showed a positive test for acid phosphatase. The second series of tests were for different types of sugars i.e. glucose, fructose and sucrose. Positive reactions were noticed for all the three and no difference in the distribution pattern of these could be observed. All these tests clearly show that secretion of nectaries consists of above mentioned sugars.

96. A study of style and stigma in relation to pollen tube growth.

I. K. VASIL and M. M. JOHRI, Delhi.

Morphology, anatomy and cytology of the transmitting tissue and the path of the pollen tubes in the style and stigma has been studied in seven plants. The pollen tubes grow through a well defined transmitting tissue and the course of their growth is predetermined. The number of carpels in a gynoecium determines the disposition of transmitting tissue.

Aegle marmelos, Fritillaria roylei and *Lilium tigrinum* possess a hollow style, while *Catesbaea spinosa, Nicandra physaloides, Pavonia zeylanica* and *Zephyranthes ajax* have solid styles. The stigmatic exudate in *Aegle* and *Pavonia* shows lipids.

In the bicarpellary gynoecium of *Catesbaea* there is a central, solid core of transmitting tissue. In *Nicandra* the gynoecium is either tetra-or pentacarpellary and the central solid core of transmitting tissue shows four or five radiating arms. In the solid styles the transmitting tissue becomes dissociated either at the time of pollination as in *Nicandra* or earlier as in *Pavonia* and *Zephyranthes*. The

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middle lamella seems to gelatinize followed by the development of intercellular spaces. The pollen tubes grow endotropically. In the ovary the pollen tube are generally transmitted ectotropically.

In the hollow styles of *Aegle, Fritillaria* and *Lilium* the pollen tubes grow along the papillate cells of the stylar caual. Pollen tubes in *Fritillaria* are conducted ectotropically in the style.

The stigmatic papillae and the cells of transmitting tissue in *Lilium tigrinum* become multinucleate due to amitosis and the nuclei fuse before pollination producing polyploid masses.

In *Catesbaea, Nicandra* and *Zephyranthes* maximum development of vascular bundle is observed in the stigma. In *Catesbasea spinosa* self-incompatibility is due to the inhibition of the growth of pollen tubes. Starch accumulates in the inhibited pollen tubes and this may be the cause or the result of incompatibility.

Intracarpellary pollen grains have been observed in *Fritillaria* and *Lilium*.

97. A contribution to the wood anatomy of Gyrocarpus.

J. VENKATESWARLU and C. BHASKARA RAMA SASTRY, Waltair.

A detailed anatomical study of the secondary xylem of the genus, *Gyrocarpus* collected from different parts of the world has been made. The xylem is characterised by the possession of several advanced features such as the presence of simple parforations, alternate intervessel pitting, homogeneous rays and vasicentric to aliform and confluent parenchyma. From these features it appears that *Gyrocarpus* shows affinity more with Lauraceae, Monimiaceae complex than with Combretaceae in which family it was included by Bentham and Hooker. *Gyrocarpus* with its essentially simple perforations of the vessel elements and homogeneous rays may be regarded as more specialised than th Lauraceous woods in which the perforations are scalariform to simple and the rays are heterogeneous. The genera *Hernandia* and *Gyrocarpous* share many important characters in common such as diffuse porous wood, solitary vessels, simple perforations, alternate intervascular pitting, paratracheal parenchyma and homogeneous rays. Therefore, on grounds of wood anatomy, the inclusion of these two genera in a single family seems justifiable.

98. A contribution to the wood anatomy of some Sonneratiaceae.

J. VENKATESWARLU and P. S. PRAKASA RAO, Waltair.

A comparative anatomical study of the woods of some members of Sonneratiaceae (*Sonneratia apetala* Ham., *Sonneratia acida* and *Duabanga sonneratioides* Ham.) was made and its bearing on the systematic status of the family discussed.

The woods studied are exclusively diffuse porous.

The woods of *Sonneratia apetala* Ham. and *S. acida* are characterized by (i) faint growth rings (ii) mostly solitary, evenly disposed, profusely tylosed, truncate, small to medium and orbicular to broadly oval vessel elements; perforations exclusively simple; inter-vessel pits numerous, typically vestured and predominantly alternate (iii) fibres medium-sized, semilibriform to libriform and mostly septate (iv) axial parrenchyma totally absent and lastly (v) almost exclusively uniseriate homogeneous rays with tanniferous and crystelliferous cells. The wood of *Duabanga sonneratioides* Ham. resembles those of *Sonneratia* except for thin-walled fibres, the presence of vasicentric to aliform parenchyma and weakly heterogeneous rays.

From this study it is evident that the woods display features both of primitive propensity and moderate phyletic advancement. A class comparison of the woods

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of Sonneratiaceae with those of related families apparently indicates that they have most features in common with Lythraceae, viz.—small to medium-sized vessels, numerous intervascular pits which are typically vestured, parenchyma exclusively paratracheal when present, rays mostly uniseriate and homogeneous to heterogeneous and fibres often septate and thin-walled to moderately thick-walled.

The above features indicate that the erection of Sonneratiaceae as a separate family does not rest on strong grounds, a conclusion also arrived at earlier on embryological grounds.

99. On the pollen of the Western Himalayan oaks.

VISHNU-MITTRE and GURDIP SINGH, Lucknow.

The pollen grains of 5 spp. of Western Himalayan oak viz., *Quercus semecarpifolia* Smith, *Q. dilatata* Lindl., *Q. incana* Roxb., *Q. ilex* L., *Q. glauca* Thunb. are so similar to one another that from their general morphological characters, it is hardly possible to distinguish these species from one another on the basis of their pollen grains.

The application of the statistical method to the data regarding the polar axis and the exine thickness collected from fifty random pollen grains of each species has helped in the segregation of five spp. into 2-3 groups, the individual members of each of which can be further separated from one another by their ecological incompatibility and distinct plant associations.

The importance of this statistical approach in tracing the history of the Oaks from the pollen-analytical investigations is also pointed out.

100. Studies of Indian pollen grains—I. Leguminosae.

VISHNU-MITTRE and B. D. SHARMA, Lucknow.

The paper deals with the pollen morphology of 326 spp. belonging to 102 genera of the family Leguminosae distributed in India. Based on the characters of apertures and the exine pattern, 67 pollen types have been recognised. More than two pollen types have been noted in the genera *Bauhinia* (10), *Acacia* (6), *Indigofera, Millettia* and *Sesbania* 4 each and in *Crotalaria* and *Erythrina* 3 each. Several other large genera such as *Cassia, Astragulus, Tephrosia, Desmodium* and *Phaseolus* are either stenopalynous or are characterised by only two pollen types.

Besides the Colpate, Colporate and porate grains already known in this family, inaperturate and spiraperturate grains have also been found. The porate grains which have so far been encountered exclusively in Phaseoleae, have also been found in the Tribe Galegeae (genus *Psoralea*).

An attempt is also made towards the application of pollen morphology to the Taxonomy of the Indian Leguminosae. Despite some encouraging results as for instance in the subdivision of the tribes Trifolieae and Eucaesulpinoideae where the pollen morphology has been found to be in accord with the taxonomy, the utility of pollen morphology in the taxonomy of the family, on the whole, is very much limited.

PHYSIOLOGY

101. On the effect of sound waves on the Respiration of flower buds of *Hamelai patens* Linn.

K. BALAKRISHNAN, Annamalainagar.

In the present investigation experiments were conducted on the effect of sound waves on the respiration of flower buds for the first time. Young flower

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buds of *Hamelia patens* Linn. were carefully selected out. After pairing them into two lots the volume was determined by the method of displacement of water. The volume was maintained precisely as 4 cc. for both the experimental and control flower buds. The experimental set was excited with the sound waves of an electric buzzer for a period of 25 minutes. Ganong's Respiroscope was used to find out the respiration value volumetrically in these experiments. It was observed that the second excited flower buds showed a higher respiration value than the control. The results were analysed statistically and have been found to be significant in favour of the sound excited flower buds at both 5% and 1% levels.

102. Amino Acid Metabolism in *Phaseolus radiatus* plants under conditions of Reduced Water Uptake.

D. BANERJI and M. M. LALORAYA, Allahabad.

Experiments carried out in this laboratory have shown large accumulation of Arginine and Asparagine in plants subjected to mineral deficiencies. From the freshweight ratio of 6 : 1 of control and experimental plants the growth inhibition could be attributed mainly to decreased water uptake. To pinpoint whether the aforesaid increment in Arginine and Asparagine levels is due to special properties associated with mineral uptake or to reduced water uptake or both, the following experments were performed.

Experimental plants were grown in Arnon and Hoagland's nutrient solution with high osmotic concentrations, viz., 0·5M, 0·25M and 0·1M of Mannitol added to reduce water uptake. Controls were kept in nutrient solution only.

Plants in 0·5M and 0·25M wilted and subsequently dried in 2—3 days whereas the growth of those in 0·1M Mannitol stopped.

Amino acid extracts from roots and stems of controls and 0·1M experimentals were subjected to two-dimensional chromatography.

The plants in 0·1M Mannitol showed much larger accumulation of Asparagine and a moderate increase in the Arginine content as compared to the controls. There was, however, a general increase of other amino acids present in the pool.

From the above results Asparagine accumulation can be attributed to reduced water uptake presumably caused by mineral deficiency and that of Arginine due probably to some mineral effect.

103. Physiological studies on salt-tolerance in crop plants.

S. N. BHARDWAJ, Agra.

In the present study, the effect of sodium Carbonate, added to the soil at 0·01% and 0·03% cocentrations, on growth and maturity of wheat and gram was investigated under pot cultures. The results indicate that the presence of the salt even in 0·03% concentration (on air dry soil) was definetely deleterious to growth of the two crops. Under favourable water supply, the crop differences in relation to their tolerance to the carbonate were not clear; with soil-droughts at the stage of vigorus plant growth (9th to 12th week after sowing), gram was less susceptible than wheat; later droughts at the maturity stage (13th to 16th week), resulted in greater depression in gram than wheat. The toxic effect was apparent from chlorosis, tip burn and premature drying of the leaves in the 'carbonate' series.

Experiment to induce tollerance to Na_2Co_3 by pretreating the seeds failed to indicate promising results. Under favourable water supply, these treatments were definitely harmful; with soil-droughts at the maturity stage, continuous soaking of seeds in carbonate solution was apparently beneficial to gram.

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104. Studies on growth behaviour of sal (Shorea robusta) seedlings in different soils (soil culture).

H. P. BHATNAGAR, Dehra Dun.

Soil culture experiment was conducted with a view to compare the results of sand culture experiment, to determine if there is any deficiency of mineral constituents in the sal soils and also to determine desirable soil properties for securing good sal regeneration, and the relation of comparative growth data to the status, good or deficient, of sal regeneration in the localities from which the samples are derived.

The study revealed that the North Kheri good regeneration area soil is significantly superior to all the others in all characters except leaf area and even in this regard it shows the maximum development. This soil derived from first quality area under *Sal-Terminalia-Moghania* community. Therefore not only is the soil good for securing regeneration but the initial growth of the seedlings is rapid and the subsequent development of the crop is also excellent.

Within the range of this study then this soil may be taken as the ideal from the point of view of sal, and other soils may be rated accordingly as they approximate to or depart from this soil in various properties.

All the soils originating from deficient regeneration areas are inferior to those originating from good regeneration areas, except for Bahraich soil from good regeneration area.

The comparison of the results of soil and sand culture experiment with regard to chemical analysis indicated clearly that with regards to Nitrogen, Phosphorus and Potassium there is no deficiency of these minerals in the soils studies. On the other hand a critical examination of all the soil determinations, i.e., mechanical physical and physico-chemical reveals that of the 14 characters, only soil pH, soil moisture in situ, water holding capacity, moisture equivalent and organic matter show indications of a definite relation to growth rate. The range of dispersion of pH values is small and much reliance cannot be placed on moisture in situ which is extremely dependent upon climatic conditions and therefore these two factors cannot be used as a basis for classifying soils with reference to development of sal seedlings.

105. Interaction of gibberellic acid and growth regulating substances of the root extract of water hyacinth *(Eichhornia speciosa* Kunth.) on the growth and flowering behaviour of rice *(Oryza sativa* var. *Chinsurah Boro I)* and gram *(Cicer arietinum* Var. *N. P. 58.)*

ROTHIN CHAKRAVERTY and S. M. SIRCAR, (Calcutta).

Interaction of gibberellic acid (GA) with growth regulating substances of the root extract (RWH) of water hyacinth (*Eichhornia speciosa* Kunth.) on the growth and flowering behaviour of a summer paddy (*Chinsurah Boro I*) and gram (*N.P.58.*) was investigated. The treatments consisted of 100 ppm. GA, root extract of water hyacinth in the conc. of 1 :5 and 100 ppm. GA plus the root extract mixed in the proportion of 1 :1 (GA+RWH). The spraying commenced with 40 days old seedlings and continued once a week till the time of flowering. All the treatments resulted in an increased height in both rice and gram plants. Death of the apical meristem after GA treatment in the gram plants was noted. GA further decreased tillering in rice and lateral branches in gram, while RWH and GA+RWH increased their growth to a great extent. All the treatments induced flowering earlier than the control and the maximum earliness was noted with plants treated with GA. Although GA increased the length of the spike but it was associated with a low

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percentage of grain formation and the grain yield per plant was greatly reduced. Between the treatments, RWH showed the best effect as the quantity and percentage of grain was greater than with other treatments.

106. Studies in transpiration in relation to sound—*Hurv crepitans* Linn.

VINCENT DANIEL, Annamalainagar.

The only experiment so far done on transpiration in relation to sound waves has been on *Bauhinia tomentosa* Linn. In the present investigation an Euphorbaceous plant *Hura crepitans* has been experimented upon. It has got a simple leaf with fortunately a very long petiole. The leaves were placed in water contained in a small bottle and a layer of coconut oil was floated on the surface of water to check surface evaporation. The specimens so prepared were subjected daily to excitation by sound waves emitted out of a tuning fork of 92 frequency for a period of half-an-hour (8-30 A.M. to 9-00 A.M.). Thereafter the excited leaves were placed in a common place along with control leaves. The loss of water was determined gravimetrically by weighting the experimental and control leaves before and after the close of the experiment.

Twenty-two experiments have been done so far and in each of them it was found that the excited leaves definitely registered a higher transpiration values to the highest extent of 200% as compared to the control. There was no doubt variation in the values but these have been correlated with the temperature and humidity of the day. The results so far obtained have been analysed statistically and have been found to be significant at both 5% and 1% levels.

The results obtained fully confirm the results of Professor Singh on *Bauhinia tomentosa* L.

107. Pollen and pollen tube studies of Morus in vitro.

B. C. DAS, (West Bengal).

In course of interspecific hybridization at Central Sericultural Research Station, Berhampore (W. Bengal) studies were made in vitro on pollens and pollen tubes of several species of *Morus* with a view to investigate how far such observations can be correlated to the data obtained from interspecific crosses.

The pollens of *Morus indica* L. var. laciniata (2n=28), *M. alba* L. var. Vishnupur (2n=28), *M. alba* L. var. Maldah (2n=28), *M. alba* L. var. China White (2n=28), *M. alba* L. var. Peking (2n=28), *M. multicaulis seringe* (2n=28) and *M. latifolia* Koidz (2n=28) are round and smooth, while those of *M. alba* L. var. Okinava (2n=28) and *M. laevigata* Wall (2n=56) generally are round, occasionally oblong or oval. In most species the average diameter of pollens varies from 12—25μ while the maximum diameter is 35μ in *M. laevigata* Wall.

The number of germ pores per pollen varies from 2—3 in most species, in a few cases they are found to be 5. Generally one or two pollen tubes grow from each pollen. The pollen tubes are unbranched in all the species except M. alba var. Peking in which the tube is bifurcated.

The percentage of pollen germination varies from 55—88 in most species while in M. laevigata Wall, it is as low as 15. The high sterility of pollens in M. laevigata Wall, it is as low as 15. The high sterility of pollens in M. laevigata Wall. may be due to its polyploid nature.

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108. Interaction of light and external application of auxin on growth of rice seedlings.

T. M. DAS and J. M. CHOUDHURI, Calcutta.

Soaked grains of rice Var. *Rupsail* were allowed to grow for 120 hours in different concentrations of IAA (0·1 ppm, 0·01 ppm, 0·001 ppm) and under following treatments of light. (1) Continuous dark, (2) 1 minute light in 24 hrs. of darkness, (3) 1 minute dark in 24 hrs of light, (4) continuous light. The intensity of light was 125 f.c. and temperature was 29·8 c.

From the result it is evident that on application of IAA mesocotyl growth was accelerated in Continuous darkness upto 28% to 50%. However, one minute exposure to light, in every 24 hrs. of darkness completely suppressed the mesocotyl growth at all the concentrations including control. It is thus evident that presence of auxin at any of these concentrations was not enough to nullify the inhibitory action of light in mesocotyl growth.

In the case of root at higher concentration of IAA a significant inhibition of growth in length was found. It is interesting to note that under continuous light the total dry weight of the root was greater than that found under continuous darkness in all concentrations of IAA including control. Such acceleration of dry weight of root under continuous light was chiefly because of the increased number of rootlets. It is also noted that only one minute exposure to light at every 24 hrs. of darkness is quite sufficient for considerable increase of dry weight of root as compared to that of continuous darkness.

109. Studies on the growth of rice tissue under submerged condition. I. The effect 2, 4-dichlorophenoxyacetic acid on exised segments of coleoptiles under

T. M. DAS and A. K. MUKHERJEE, Calcutta.

Coleoptile segments of rice were cultured under submerged condition as well as under floating condition. On application of 2,4-D a sharp and significant increase in growth in elongation was recorded.

At higher concentrations e.g., 100 and 10 ppm the growth rate was higher in floating segments of coleoptiles. But at lower concentrations, including control, the growth rate was higher in submerged ones, which apparently indicates that the optimum concentration of 2,4-D for growth of rice coleoptile is shifted with shifting of oxygen tension. Three different mutually opposing factors namely, lowered auxin destruction under submergence, concentration of auxin in the plant tissue and lowered aerobic respiration have been stated to be responsible for growth of rice tissue under water.

110. Effect of different sugars on the growth of pollen tubes of *Corchorus siliquosus* L., a willd jute of America.

R. M. DATTA and B. S. PANDA, Calcutta.

Pollen grains were cultured on 8% lactose gelatin agar and 4% sucrose gelatin agar. Measurements were taken on two days in the months of November and December, 1960. In this wild jute species 8% lactose gelatin agar was found stimulating, where maximum pollen tube growth of 947·28 μ was recorded.

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111. Effect of Boron on the induction of rooting in case of hormone treated materials.

A. S. DUBEY, Patna.

The present work is in continuation of the author's previous report that the micronutrient Boron induces earliness in roting the normone treated *Myrtus* stem cuttings. It has now been confirmed in case of stem cuttings of *Hibiscus rosa sinensis* L. and isolated leaves of *Porana paniculata* Roxb. and *Celosia cristata* Linn. Stem cuttings of Hibiscus were treated with 100 p.p.m whereas the isolated leaves of *Porana* and *Celosia* were treated with 20 p.p.m. I.B.A. for 24 hours. Then they were washed thoroughly and kept in water in the rooting chamber, i.e. in diffused light and in humid conditions. Water was changed daily in all the cases. After callus formation, Boron was sprayed over the leaves in the form of moric acid in very low concentrations, i.e. 10 p.p.m. It was observed in all the cases that healthy roots came out earlier than in the control sets, i.e. only hormone treated ones.

112. Effect of Gibberellic Acid Like Substances on the Growth Elongation of Mustard T. 102 Seedling Hypocotyls.

GYANENDRA VERMA and D. K. VERMA, Almora.

Gibberellic acid like substances were isolated from (A) shells of green pods of *Clitorea ternatea*, (B) flowers of *Cuscuta* and (C) fresh sprouts of Potato var. Uptodate. 1 in 10 water extracts containing gibberellic acid like substances were prepared by methods described earlier (Verma, D.K., Proc. 48th Ind. Sci. Cong. III, p. 323, 1961).

Optimum concentrations of these extracts which induced maximum growth elongation of mustard T. 102 seedling hypocotyls were found to be 1/100 for (A), 1/1000 for (B), 1/100 for (C). Comparison of these extracts with glass distilled water and with the optimum concentrations of similar extracts of (D) immature seeds of *Clitorea ternatea* and (E) tender vines of *Cuscuta* showed that the best elongation of both hypocotyls and roots of mustard T. 102 seedlings was given by 1/100,000 extract of (E), followed by 1/50,000 extract of (D), followed by (A), (B) and (C). Extracts of shells of green pods of *Clitorea*, or *Cuscuta* flowers and of Potato sprouts induced similar growth elongation of seedling hypocotyl. Except for (A) which induced root length similar to control (GDW) all the extracts stimulated better root length than GDW. All the extracts induced better hypocotyl growth than GDW.

This work was carried out in connection with the Scheme of Plant Physiology and Cytology financed by the Indian Council of Agricultural Research, New Delhi.

113. Effect of Water Extracts of Fertilised Gynoecia of Garden Pea on Growth Elongation of Pollen Tubes.

GYANENDRA VERMA and D. K. VERMA, Almora, U.P.

Effects of water extracts of gynoecia of Garden pea (*Pisum sativum*) var. English Wonder flowers collected (A) before pollination and (B) 24 hours, (C) 48 hours and (D) 72 hours after pollination on the growth elongation of garden pea pollen tubes, were observed.

Optimum concentrations of these extracts which in control medium (12·5% sucrose solution + 1% agar) induced maximum elongation of garden pea pollen tubes were found to be A/200, B/300, C/200 and D/100. Compared to the growth

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elongation of 360 microns in 6 hours in control medium that induced by the four extracts at 1 :200 level were A/200 508 microns, B/200 624 microns, C/200 520 microns and D/200 384 microns, while the lengths of pollen tubes induced by their obptimum concentrations were A/200—508 microns, B/300-746 microns, C/200-520 microns and D/100-466 microns.

Estimations of amino-acids and sugars, present in the gynoecia at each stage were made by chromatographic technique. In all, 10 spots of amino-acid groups were obtained. Areas of spots of amino-acids, in general, increased to a maximum in the chromatograms of B and then gradually declined in those of C & D. Ornithine, Dl-2-aminobutyric acid and isoleucine-leucine were maximum in A and gradually decreased in B, C and D, Ornithine being absent in C and D. Lysine-Histidine were not present in A, but appeared in B and gradually declined in C and D. Citrulline, Glutamic acid-aspartic acid-threonine were highest in B and decreased thereafter. Arginine-Serine-Glycine-Tarusine-Creatine were highest in C and decreased thereaftr. Except methionine-valine the areas of the different amino acid groups were smaller in D than in A.

Only one spot of sugars was developed in chromatograms of A and B, the area being 80 and 85 sq. mm. respectively. In chromatograms of C and D no sugars were detected.

These results show that amino-acids and sugars (and possibly other growth regulators) increase rapidly during the first 24 hours after pollination and then decrease progressively, as is also shown by the growth elongation of pollen tubes induced by different extracts.

There studies were carried out in connection with the Scheme of Plant Physiology and Cytology financed by the Indian Council of Agricultural Research, New Delhi.

114. Studies in the Phosphorus Fractionation in some edible leaves of plants grown in Bombay and its Suburbs—Part III.

SMT. KARKAL, MALINI, and B. S. NAVALKAR, Bombay.

The investigation on phosphorus content was carried out on some edible leafy vegetables of every day use in Bombay. In this third series the plants analysed were *Raphanus sativus*, L. (Mula, radish), *Trigonella foenum*, Graecum. (methi, Fenugreek), *Moringa oleifera*, Lam. (Shevga, drumstick), *Allium cepa*, L. (Kanda, pyas, onion), *Colocosia antiquorum*, Schott. (Alu-black, elephant's ear), *Portulaca oleracea*, L. (Gnol), purslane), and *Basella alba*, I. (Mayali, indian spinach).

Nitric-perchloric acid digestion as recommended by Hardin et. al. was used for Total Phosphorus determination. Acid-soluble phosphorus was extracted in 10% Trichloroacetic acid and digested with nitric acid. Lipid phosphorus was extracted with ether-ethanol mixture. Inorganic phosphorus was extracted with Trichloro-acetic acid and this extract was used directly. The phosphorus content was determined colorimetrically by using photoelectric colorimeter, according to A.O.A.C. procedure.

All plants were collected from the same locality to minimize the difference in environmental factors. The results show that the plants are sufficiently rich in their phosphorus contents (124·35—871·64 mgm/100 gm), and could be ordinarily used even by economically lower groups in society to keep up the nutritive balance of phosphorus in their every day diet. The moisture content is sufficiently high (75·79—90·40%), except in Moringa oleifera (30·68%). Further the conclusions drawn from the laboratory tests can serve only as rough guide.

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115. A note on the effect of Gibberellic Acid on two forage plants : *Sorghum sudanense* and *Trijolium alexandrianum*.

SUDHIR KUMAR and D. GUPTA, Jobner (Rajasthan).

The effect of Gibberellic Acid has been studied on the growth yield and root development in *Sorghum sudanense* and *Trifolium alexendrianum*. Plants were sprayed with three different concentrations of G.A. viz. 200 ppm, 100 ppm ad 50 ppm. The results indicate that plants sprayed with G.A. show increase in yield and growth. At 200 ppm it was observed that root development was inhibited.

116. A note on the mechanism of Auxin action.

M. M. LALORAYA, Allahabad.

The presence of a strong negatively charged group at an unobstructed distance of 5·5 Å units from a weak positively charged group in the auxin molecule coincides well with the distance involved in the formation of hydrogen bonds between the $-CO.NH$ group which hold the peptide chain in the α-helix structure of the protein and between the hetero-polar bonds in the wall material. Models based on the interactions of bonds and the charges in the auxin molecule and that in the protein and wall structure, have been proposed to explain the mechanism of auxin action in plants. The diverse observed effects of auxin have been explained in terms of the two models.

117. Effect of Gibberellic Acid on Rice.

G. MISRA and G. SAHU, Cuttack.

The effects of Gibberellic acid (GA) on the growth and development of two varieteies of rice, one early, N.136 and the other later J.192, have been studied. The treatment consisted of soaking the grains separately with 1, 10, 100 and 500 parts per million (ppm) of GA for 72 hours and the subjecting the plants thus obtained to weekly foliar spray with the same concentration of the chemical with which the grains were initially soaked. GA brought about a significant earliness in flowering at lower concentrations, whereas at the highest concentration of 500 ppm an opposite effect, namely delay in flowering was observed in both varieties. With regard to certain aspects of vegetative growth such as the production of tillers and leaves, the chemical had an inhibitory effect particularly at the high concentrations of 100 and 500 ppm and that, too, more prominently in the late variety of rice. As is very characteristic with the chemical it brought about a marked increase in height of the treated plants, the maximum increase being observed at 500 ppm, the highest concentration used. The other outstanding result is a significant increase up to a maximum of 25% in the yield of grains from plants treated with the two lower concentrations of 1 and 10 ppm of the chemical. The higher yield was mainly due to the formation of greater number of panicles in the treated plants in comparison with the untreated controls.

118. Effect of Maleic Hydrazide on Rice.

G. MISRA and G. SAHU, Cuttack.

The response of two different varieties of rice, N.136 (early) and J.192 (late) to the treatment of various concentrations of Maleic Hydrazide (MH) was studied. The treatment consisted of soaking the grains prior to sowing for 72 hours sepa-

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rately with 1, 10, 100 and 500 parts per million (ppm) of MH followed by a post-sowing foliar spray with the same concentration of the chemical with which the grains were initially soaked. The spray commenced with 28-day-old seedlings and was continued till the time of ear emergence. The grains soaked with 500 ppm of MH germinated alright ubt the seedlings did not grow any further. Hence no data could be collected from this set. With regard to the rest of the treated sets a slight but significant earliness in ear emergence was observed at the lowest concentration of 1 ppm more particularly in the early variety and the opposite effect i.e., delay in ear emergence at the concentration of 100 ppm in both the varieties. The vegetative growth as reflected by the production of tillers and leaves, though, showed a decrease in the early stages mainly in the late variety, on the average was not markedly changed at the mature stage from that of the untreated controls but there was a distinct increase in height in both the varieties under the influence of the lowest concentration of 1 ppm. The grain yield of the treated plants did not significantly vary from that of the controls.

119. Effect of Plant Growth Substances on Rice.

G. MISRA, Cuttack and D. MISHRA, Sambalpur

The effect of three plant growth substances, IAA, NAA and TIBA at 1, 10 and 100 parts per million (ppm) upon the growth and reproduction of four varieties of rice, N. 136 (early), T. 1145 (early-winter), T. 141 (mid-winter) and J. 192 (Late-winter) has been studied. The treatment consisted of a preliminary seed saoking for 72 hours followed by a weekly foliar spray, beginning at the week and continuing until ear emergence. IAA produced a significant earliness in ear emergence in the early, mid-winter and late-winter varieties. NAA had no effect on early and early-winter varieties but produced a significant earliness in the mid-winter and late-winter varieties. TIBA had but little effect on early and early-winter varieties and produced a significant earliness in the mid-winter and late-winter varieties. Thus the three growth substances bring about different results even in the same variety of rice and also the different varieties respond variously even to the same growth substance. With regard to grain yield it wos seen that IAA at 100 ppm. brought about a higher grain yield in the early, early-winter and late-winter varieties. TIBA also increased the yield of the early variety at 100 ppm and the early-winter variety at 1 and 10 ppm and that of the mid-winter variety at the three concentrations used. NAA had a depressing effect on yield particularly in the early-winter and mid-winter varieties.

120. Estimation of Absolute Stomatal Numbers in Ipomoea Carnea Jacq. growing in two different habitats.

PRASANNA KUMAR MOHANTY, Sambalpur.

There is no conclusive evidence as yet if the environmental conditions influence the frequency of stomatal number. The leaves of two healthy branches of two plants of the species *IPOMOEA CARNEA*, Jacq; were selected and five leaves from, each branch were plucked, begining from the first unfolded leaf, and were serially numbered. Then the area of each of the leaves was determined. Then the upper and lower epidermises were separated in the manner of Gupta (1960) by the treatment of concentrated colourles Nitric acid. Stomata were counted under the microscope, whose field of focus was previously standardized.

The average number of stomata per unit area was then calculated and the total stomatal number or "Absolute Stomatal Number" was obtained by multiplying this value with the total leaf area.

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A graded difference was observed in the average stomatal number per unit area in two corresponding leaves. Their total stomatal number per leaf-lamina is seen to be more or less constant. This value is constant in matured leaves only. In this particular species, the difference in stomatal nnmber per unit area in both the epidermes is not very sharp.

121. A preliminary study in the variation of water and dry matter in the leaves owing to a change in habitats.

S. NAIK and P. K. MOHANTY, Sambalpur.

It is well known fact that the habitat exerts certain influence on the growth of plants. The present paper aims at determining the total dry matter in the first five leaves of a commonly occuring plant *Ipomoea carnea*, growing at Sambalpur in marshy (semi aquatic) and in ponds (aquatic). Leaves from first 5 nodes of plants growing in water (nearly 3ft-deep water) as well as plants growing in a marshy community were detached. As many as 15 to 20 healthy leaves were selected from each nide. The petioles were cut off from the base of the lamina, and each sample was weighed. A number of circular discs were cut with a punch and the number of discs in a weighed sub sample was counted. These discs were dried in an even at 100° at 1000 mm of Hg.

The areat per unit weight of lamina was calculated from (a) the number of discs (b) the known area per disc and (c) the fresh weight of the sample. It was then multiplied with fresh weight of lamina and divided by the number of leaves to give the average leaf area.

It was observed that although *Ipomoea carnea* growing in water have got on the average a reduced leaf surface compared the corresponding leaves of the same semi aquatic plant, but there is no remarkable difference in the production of dry matter. This is more evident in matured leaves. The percentage of loss of water on the average in the aquatic and semi aquatic leaves was found to be 69·0 and 74·5 respectively.

122. Exposure of Sesamum orientale L. to Chronic Gamma Irradiation—its response to flowering and growth.

G. G. NAIR, Bose Institute, Calcutta.

Sesamum orientale L. var *T 16* (West Bengal) plants were grown in concentric rows around a cobalt 60 gamma irradiation field source, with an initial activity of 14·85 curie. The plants were exposed to irradiation for about 17 hours a day, from sowing upto the time when all plants completed flowering. These plants were compared to the control plants grown outside the effective area of the gamma source. The irradiated plants showed earliness in flowering from two to six days and also stimulated growth and increased number of branches as against the control. The plants that were grown under highest dose rate (41,401·0 mr. per day) i.e. nearest to the source had minimum stimulation in flowering and vegetative habit and approached the condition in the control, as compared to other lower doses (4,599·1 mr; 1,656·1 mr; 845·2 mr; 511·3 mr; 342·9 mr; 245·8 mr; 184·0 mr. and 115·4 mr. per day) where significant difference in mean heights and mean number of branches were observed.

123. On the effect of sound waves on the growth of sugarcane.

S. PANNIRSELVAM and P. SANKARANARAYANAN, Annamalainagar.

In the present investigation, sugarcane variety CO.527 was subjected daily to the sound waves of an electrically run tuning fork, for a period of exactly half-

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an-hour in a nursery 16 feet×8 feet located in the University Botanic Garden. Besides, a control plot of the same dimension, having the soil of same texture and constitution, with the very same sugarcane variety grown in it, was also maintained. Observations were periodically made on germination, tillering, thickness of the mother cane and length and breadth of leaf.

After a total period of eleven months, the cumulative effect of the sound waves are now very clearly visible, namely there is a great difference in height measurement and thickness of the stem, tillering and size of the leaf. In each of these obserrvations, the excited plants expressed higher values than the control. The results have been statistically computed and have been found to be highly significant, at both 5% and 1% levels.

These results are in full agreement and confirmation of the results obtained by Professor Singh (1960) in respect of two sugarcane varieties namely a thick chewing variety and another sugarcane variety CO.719.

124. Regulation of Hypocotyl growth in epigeal seedlings.

V. K. RAI and M. M. LALORAYA, Allahabad.

The regulation of hypocotyl growth in two distinct types of epigeal seedlings—one in which the cotyledons act only as an organ of storage and falls off during the growth of the seedlings (type I) as compared to the other in which case the cotyledons expand and grow and take the function of the first primary leaves (type II) has been studied.

It has been shown that while 100 ppm of IBA inhibits hypocotyl growth in type I seedlings (*Phaseolus mungo*) and that this inhibition is reversed by 5 ppm of GA 3; in type II (*Luffa aegyptiaca*) the inhibition of the hypocotyl growth is reversed at the cotyledonary leaves start growing i.e. after 3rd day in light. That this reversal is chiefly due to the growth of the cotyledonary leaves in light is borne out by the fact that seedlings grown in dark continue to exhibit a marked reduction in the growth of hypocotyl as compared to control.

In the epigeally growing Tamarind seedlings two new gibberellins have been detected which react to permanganate test and ffuorescence in presence of H_2SO_4 in ultra violet light. GA 3 alone is known to give this fluorescence and co-chromatographing with GA 3 although showed similar fluorescence, these gibberellins had lowered Rf values as compared to GA 3. The gibberellins in Tamarind are thus close to the GA 3.

It is suggested that interaction of auxin and gibberellin is in control of the hypocotyl growth.

125. Studies on the effect of different concentrations of Sodium Chloride and Sodium Carbonate in nutrient solutions on growth of groundnut (Var. TMV 4) in sand cultures.

G. RAJESWARA RAO and I. M. RAO, Tirupati.

The tolerance of groundnut plants (variety TMV 4) to a treatment of Sodium Chloride and Sodium Carbonate as studied. The plants were raised in pots filled with river sand. The plants received besides culture solution 0·2% and 0·8% NaCl solution in one set and 0·1% and 0·2% Na_2CO_3 solution in another set. The solutions were added daily and every third day during the first 30 and next 30 days respectively. One control series receiving only nutrient solution was also maintained.

The plants were thinned out at the end of 30 and 60 days after sowing and the oven dry weight of the shoot was determined. The average dry weight of

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shoot per plant in each treatment was calculated as percentages on control for the treated plants. Compared to the controls, plants treated with 0·2% NaCl showed a marked decrease with age in shoot dry weight (the reduction being 5·3% and 21·4% for the 30 and 60 day old plants.) whereas with 0·8% the decrease is slightly accentuated at both stages of growth.

With 0·1% Na_2CO_3 the reduction in shoot weight is much less (the reduction being 2% and 4·5% at 30 and 60 day old plants respectively. However, with 0·2% treatments the corresponding reductions at the two stages are 17% and 20%. Thus groundnut plants seem to be susceptible like other legumes (e.g., gram) to soil salinity and alkalinity.

Investigations are in progress to find out the effect of NaCl and Na_2CO_3 on yield and growth characters of groundnut.

126. Observations on the effect of sound waves on the stomatal frequency and index of *Urginea indica* Kunth.

K. RANGASWAMI AYYANGAR, Annamalinagar.

Previous reports in this laboratory have shown that sound waves produced by the tuning fork have the effect of increasing the rates of vital processes of plants, like carbon assimilation, respiration and transpiration. It is common knowledge that the stomata play a significant role in the regulation of physiological processes, and so the present undertaking was intended to see how far these stomata are affected by the sound waves. For this purpose, bulbs of *Urginea indica* Kunth., the Indian Squill, were planted in a plot of ground in concentric circles in the centre of which an electrically run (Cenco, U.S.A.) tuning fork (of 92 frequency) was placed. The tuning fork was switched on for 30 minutes every day at 6 A.M. The blubs were so disposed, that no bulb was more than 3 feet distant from the tuning fork. Another plot was chosen far away from the previous one, where also bulbs of *Urginea indica* Kunth., were planted. Care was taken to see that the size and number of bulbs and the pattern of their planting as also the nature of the soil were identical in both the plots. Epidermal peals from the lower and upper surfaces of mature leaves of the control and experimental plants were examined and stomatal counts were made. From the counts so made, stomatal indices were also calculated. Statistical comparisions were made between the stomatal indices of the lower and upper epidermises of the control and experimental plants. From these studies, it became evident that the stomatal frequency per unit area in the lower epidermis of the sound-treated plant was 45% greater than that of the control. In respect of the upper epidermis, it is 27% more in the experimental than in the control. Furthermore, the stomatal indices of the lower and upper epidermises of the experimental plant were far higher than those of the control and in fact the higher values of stomatal index registered by the experimental in contrast with the control have been found to be statistically significant.

As is well known, the stomata play a strategic role in the excanges of gases and moisture between the mesophyll of the leaf and the external atmosphere and naturally any change in them is bound to exercise profound influence upon physiological processes like photosynthesis, respiration, transpiration, growth and reproduction. Therefore, changes in the stomatal frequency brought about by sound waves impinging on the leaves, afford a scientific basis for the higher rates of vital processes observed by the previous workers.

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127. Studies in the activation of carbon assimilation of *Aponogeton monostachyon* Linn. by sound waves.

N. C. RATHAKRISHNAN, Annamalainagar.

Recently it has been shown by Professor Singh and his collaborators that sound waves have an activating effect on the carbon assimilation of hydrophytic angiospermic plants like *Hydrilla verticillata* Presl., *Lagarosiphon roxburghii* Benth., *Vallisneria spiralis* Linn., *Ceratophyllum* and others. These experiments have in consequence been extended in this investigation to *Aponogeton monostachyon* Linn. It is a submerged aquatic angiospermic plant which grows very plentifully in the University boating canal with a view to investigate as to how far the results from it could confirm previous findings.

Experiments were conducted with all the meticulous care and control as in previous experiments. As a result of 24 experiments, it has been observed that the quantum of carbon assimilation as judged from the evolution of Oxygen in the experimental sets excited by sound waves, is far superior to those of the control sets not excited by sound waves.

The resultant data of all the 24 experiments were subjected to statistical analysis and they have been found to be very highly significant at both 5% and 1% levels by Fisherian 't' test. This therefore further confirms the previous findings showing thereby the great extent sound waves affect carbon assimiliation.

128. Studies on isolated plant nuclei. I. Tracer studies on nucleic acid metabolism in coconut milk.

R. ROYCHOUDHURY and S. P. SEN, Bose Institute, Calcutta.

The metabolic interrelationship of DNA and RNA is a matter of considerable interest. Coconut milk with its ree endosperm nuclei has been found to be a very suitable material for such a study since the nuclei and 'cytoplasmic fraction' can be easily separated by centrifugation. Intact green coconut was injected with radiophosphorus and after 18-20 hrs. of incubation P^{32}—labelled nuclei and cytoplasmic fractions were separated. A similar unlabelled preparation was obtained from another coconut which did not receive any P^{32}. Labelled nuclei was then incubated with unlabelled 'cytoplasm' and labelled cytoplasm with unlabelled nuclei. After incubation the DNP from the nuclei and RNP from the cytoplasmic fraction were isolated. It was observed that labelled nuclei had transferred P^{32} to the unlabelled cytoplasmic RNP and *vice versa*. Both DNP and RNP were hydrolysed and paper chromatographic separation of the products revealed the presence of P^{32} in some of the nucleotides of RNA and DNA. That such a transfer was enzymic and not purely due to exchange reactions was shown in experiments in which boiled preparations were used.

In later experiments labelled nuclei were treated with D Nase and incubated with unlabelled cytoplasmic fraction. Under such conditions the cytoplasmic RNP incorporated much less P^{32} than the control, indicating a DNA control of RNA synthesis. If on the other hand the labelled cytoplasmic fraction is treated with R Nase (expected to affect both cytoplasmic and nuclear RNA) and incubated with unlabelled nuclei, P^{32} incorporation into nuclear DNA is increased as compared to that in the control. The increased incorporation is probably due to utilisation of the degradation products of RNA by the nuclei. DNA synthesis thus appears to be independent of both nuclear and cytoplasmic RNA.

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129. Tracer studies in the post-harvest physiology and biochemistry of mango.

S. P. SAHA and S. P. SEN, Calcutta.

The biochemical changes occuring in detached mango fruit has been studied using $C^{14}O_2$ and Na acetate–1-C^{14}. Mango fruits in different stages of ripening were used intact or separated into peel and pulp. In the intact mature green (unripe) fruit, allowed to photosynthesise in $C^{14}O_2$, most of the C^{14} was located in the peel. The separated peel revealed the typical products of photosynthesis, in the peel of the intact fruit, however, very little C^{14} was located in sugars or amino acids. The pulp of the intact fruit incorporated relatively small amounts of C^{14} largely distributed in malic acid, sugar phosphates and a few amino acids but free sugars were practically free from radio-activity. As the period of storage was increased C^{14} activity in both the alcohol soluble and insoluble compounds of the peel gradually decreased accompanied with a corresponding increase in the radio-activity of the alcohol-insoluble fractions of the pulp. No marked change was observed in the activity of the alcoholsoluble fraction of the pulp. Phosphoglyceric and malic acids became increasingly radioactive while C^{14} activity in sugar phosphates gradually decreased. In the pulp $C^{14}O_2$ fixation pattern in light was identical with that observed in complete darkness. The pulp fixed more C^{14} in darkness than in light. In the peel C^{14} was fixed largely in sugar phosphates, phosphoglyceric acid and malic acid.

The ripe fruit with a green skin fixes more C^{14} into its peel and pulp than the fruit with a yellow skin. In the peel of the ripe fruit, very little C^{14} is found in sucrose even though the peel is green. A compound with low Rf values in phenol-water and Butanolacetic acid-water was detected only in the pulp of the ripe fruits. C^{14} activity in the peel, however, was always greater than that in the pulp no matter what the degree of ripeness was. Pulp of the yellow ripe fruit metabolised acetate–1-C^{14} only very weakly as compared to the green mature fruit.

130. Effect of Gibberellic acid on vegetative growth of *Spinacia oleracea* L.

B. SAMANTARAI and T. KABI, Cuttack.

The effect of gibberellic acid (GA) on the growth and development of *Spinacia oleracea* was studied. Soaking the seeds in aqueous solution of GA at different concentrations had little effect on the rate of germination, but the plants grown from the seeds soaked with 50 ppm. of GA showed more vegetative growth, than those treated with other concentrations and the controls. Periodical administration of GA showed promising results. There doses of GA at 10 ppm. induced best vegetative growth. The following criteria were considered to ascertain the vegetative growth : (1) Average number of leaves per plant, (2) Average number of branches per plant and (3) Fresh weight of the shoot.

131. Auxin control of secondary growth in the petioles of Herbaceous Dicot leaves. III—Enhancement of secondary growth by the application of synthetic hormones and inhibition of secondary growth by the application of auxin-antagonisers in the petioles of *Boerhaavia diffusa*.

B. SAMANTARAI and T. KABI, Cuttack. (Orissa)

Secondary growth does not take place in the petioles of *Boerhaavia diffusa*, when the leaves are attached to the stem. Profuse secondary growth in the petiole was observed when the leaves were isolated and treated with synthetic hormones.

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So the leaves of *Boerhaavia* were selected to study the factors concerned in the secondary growth. Experiments were performed in three ways, viz., (1) with isolated leaves, (2) attached leaves with girdles above and below the nodes and (3) attached leaves without girdles. The hormones used in these experiments were β-indolyl butyric acid (IBA), β-indolyl acetic acid (IAA and α-Napthyl acetic acid (NAA). Auxin-antagonisers like Maleic hydrazide (MH), Phenyl mercuric nitrate (PMN), and 2,4-dichloranisole (DCA) were used in these experiments. To study the role of food factor, sucrose and asparagine and some 'B' vitamins were administered. Synthetic hormones, auxin-antagonisers and food substances were administered separately and in different combinations at different concentrations. It was revealed from these experiments that auxins whether native or applied enhanced secondary growth and auxin-antagonisers inhibit secondary growth either partially or completely. In the attached leaves, girdling the stem above and below the node produced secondary growth whereas ungirdled leaves had no secondary growth. Food substances like sucrose, and asparagine and 'B' vitamins did not produce any effect on secondary growth. Therefore it is suggested the secondary growth is chiefly brought about by the auxins which may be native or synthetic.

132. Factors concerned in secondary growth in the stem of *Solanum melongena* L.

B. SAMANTARAI and B. K. NANDA, Cuttack.

Investigations were carried out to determine the factors concerned in secondary growth in stems of *Solanum melongena* L. Plants were treated with β-Indolyl butyric acid (IBA) before any cambium was formed in them. Such plants produced copious secondary growth. The amount of secondary growth, when measured, was more than the untreated ones.

Administration of auxin-antagonisers like Maleic hydrazide (MH), Phenyl mercuric Nitrate (PMN) and 2, 4-Dichloroanisole (DCA) lowered down the magnitude of secondary growth. Repeated application of these substances completely inhibited secondary growth. These auxin-antagonisers, however, along with IBA, although reduced secondary growth could not inhibit it completely even under repeated administration.

Treatment with food substances like sucrose and Asparagine either singly or in combination with auxin-antagonisers did not brirng about any effective change. in fact, they had no significant role in controlling secondary growth.

The enhancement of secondary growth by the application of hormones and the inhibition of secondary growth by the application of auxin-antagonisers suggest that secondary growth in stems is primarily controlled by hormones.

133. A preliminary survey of auxin disappearance from the medium by slices of different plant material.

B. SAMANTARAI, S. K. SINHA and M. S. RAO, Cuttack.

One of the effects of auxins on plants is the induction of roots and secondary growth. But formation of roots and production of secondary growth by the application of synthetic hormones are not found in most of monocots and no rooting response in ferns. In order to investigate the fate of auxin that is externally supplied to different plant species slices of tissues were floated in solutions of IAA. The concentration of IAA at intervals of 20 minutes were determined by a method suggested by Tang and Bonner. The method consists of a ferric chloride-sulphuric acid reagent, when added to aqueous solution of IAA, a red colour is developed, which reaches its maximum intensity after 15 minutes. The red colour

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was then compared with Lovibond Tintometer. A standard curve was prepared with 50, 40, 30, 20, 10 and 5 ppm. (parts per million) of IAA against their respective readings expressed in Lovibond units. The plant parts investigated were cut in to uniform sized (1 mm.) discs and kept in 50 ppm. of IAA for 20 minutes. Then 1 c.c. of the aliquot was mixed with 4 c.c. of Tang and Bonner reagent and allowed to stand for 15 minutes when it developed its maximum intensity of colour. The colour was compared with Lovibond Tintometer. In the same way the readings were taken with all the aliquot at every 20 minutes interval. With the standard curve the Lovibond units were converted to ppm. The experiments were repeated with a number of plant species belonging to monocots and dicots and some ferns responsive and non-responsive as to rooting response or secondary growth as the case may be.

It was found that the disappearance of auxin from the incubation mixture was the most rapid in certain monocots especially in *Polyanthes* and in Ferns, where 50% of IAA disappeared in less than 20 minutes. No induction of roots or initiation of secondary growth is possible with IAA in Polyanthes and Fern. So the decrease of IAA from the solution supplied externally may be due to destruction by the tissues or inactivation by an unknown enzyme system present in the tissues. The destruction may be inside the tissues or in the medium since the cell sap which exude from the cut surfaces of the discs contain this enzyme system. This investigation has some important bearing in the problem of induction of roots and initiation of secondary growth by auxins. Further studies in this line are in progress.

134. On the effect of sound waves produced by Tuning Fork on the mitotic behaviour of *Urginea indica* Kunth (Indian Squill).

P. SANKARANARAYANA, Annamalainagar.

Since 1950, quite a lot of work has been done in the Botany Laboratory of Annamalai University on the effect of musical sound on growth and reproduction of plants. It has been seen that in plants like *Mimosa, Impatiens, Ipomaea* and others, vast perceptible histological changes take place as a result of excitation by sound. The size of the epidermal cells and palisade cells has been found to be larger in the experimental plants than controls.

Two sets of identical bulbs equal in size were grown in pots and in bottles maintaining other factors like soil and water also in an identical manner. One set served as the control and the other as experimental. The bulbs were excited by an electrically run tuning fork whose frequency was 96, for a period of 30 minutes. The root tips that emerged out from both the control and experimental were fixed in Acetic alcohol and acetocarmine squashes were made. It was noticed that the total number of cells that were undergoing division and the various stages of mitotic division in the experimental root tips was greater than those of the control. It was found that the coming out of root tips was earlier in the bottles containing water than in pots. The various stages of mitotic division were tabulated and statistically analysed.

It was evident that the sound waves of tuning fork have increased the rate of mitotic division. Interestingly enough, in the experimental root tips far more cells were in the meta-ana and telophose stages than in the controls. The inference is that the sound waves impinging on the protoplasm stimulates the otherwise quiescent nuclei to mitotic activity. The phenomenon of more vigorous growth is to be attributed to the stimulation of the cell protoplasm into greater activity which results in more rapid and more frequent nuclear division and the consequent increased growth rate and augmented size of plants concerned. Likewise here the

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mitotic division is speeded up by sound and this naturally results in the rapid elongation of the roots.

135. On the effect of sound waves on the growth and bio-chemical changes in the seedlings of *Sorghum vulgare* CO-19.

Miss P. P. SAROJINI, Annamalainagar.

In the present investigation, a study was made for the first time on *Sorghum vulgare* variety CO-19 under the excitation of sound waves produced by an electrically run buzzer.

Unlike other seeds where there is definite difference in germination under sound excitation, in this case there is however, ,no such difference in germination, under the influence of sound waves, except the difference in vigour between treated and non-treated seedlings. Experiments in petri-dishes were conducted by varying the period of excitation viz. 15 minutes, 30 minutes, 45 minutes and 60 minutes. Best results in the form of growth performance, have been obtained under 30 minutes excitation.

Respiration of the germinating seeds under different periods of sound excitation was also studied. It was observed that the optimum respiration values were obtained under 30 minutes and 45 minutes excitation.

Bio-Chemical analyses of experimental and control plants were done. Under pot-culture, 45 minutes excitation gives the best results with regard to shoot system, root system, C/N ratio, Cellulose content and total sugar. No difference has so far been found in respect of the nitrogen content. Further work is in progress.

136. Photoperiods in *Hyptis Suaveolens* Poit.

M. C. SAXENA, Raipur.

Hyptis suaveolens Poit. belonging to family Labiatae is an annual to perennial species widely distributed in Chhattisgarh Divison (M.P.). Being an annual it starts its growth in nature with the onset of monsoon. Flowering sets in by the end of October when the plants are nearly four months old and 1 to 2 m. high.

Plants of *Hyptis suaveolens* Poit. were grown in 3 replicates under 6 hour, 8 hour, 12 hour, 18 hour, 22 hour, 24 hour and normal photoperiods. Data has been obtained regarding the length of plant, vegetative and reproductive grgowth. The following facts are also noted concerning the response of this species to the length of the photoperiod :—

(i) The plant is a short-day one. Flowering takes place on the 44th day of transplanting the seedling with 8 hour photoperiod.

(ii) The plants with 6 hour photoperiod flower on the 49th day of transplantation.

(iii) There must be a critical length of photoperiods between 6 hour and 10 hour with respect to the age at which flower buds are initiated.

(iv) When the plants were exposed in lengthened photoperiods e.g. 16 hour, 22 hour and 24 hour the growth is more vegetative. These plants are fairly robust, with thicker stem, broader leaves and dense thick hairs.

137. Studies in Root Initiation in Isolated Cotyledons and in Different Portions of Hypocotyls of Mustard T. 102 Seedlings.

B. SEN and G. VERMA, Almora.

Similar cotyledons isolated from young seedlings of mustard T. 102 were cultured in (a) G.D.W., (b) nutrient solution ½ strength, (c) 20 ppm KNO_3 in

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normal day light and (d) in ½ nutrient kept in dark at room temperature. The number of cotyledons which developed roots and the time taken for root emergence were (a) 55%; 9·7 days, (b) 90%; 6·6 days, (c) 70%; 8·2 days and (d) 52%; 6·2 days. Cotyledons kept in dark had smaller blades and longer petioles.

From seedling hypocotyls of mustard T. 102 (length 20±1 mm.) (A) 5 mm. apical fragments with cots, (B) 5 mm. apical fragments without cots, (C) top 5 mm. portion of hypocotyl without growing point, (D) middle 5 mm. portion and (E) bottom 5 mm. portions were isolated and grown for 2 weeks in ½ strength White's nutrient solution, alone and with IAA 0·5 ppm. Roots emerged earliest in (A) following by (E), (D), (C) and (B). With IAA the root emergence was 100% in (A), 76·7% in (E), 50% in (C), 48% in (D) and 40% in (B); without IAA it was 100% in (A), 50% in (B), 40% in (C) and 20% in (D).

Effects of removing one or both cotyledons from 2 to 5 mm. apical fragments of mustard T. 102 (i) in the beginning and after, (ii) 24, (iii) 48 and (iv) 72 hours on the sequence of root emergence in tissues grown in White's nutrient solution at room temperature were observed. In another set of apical fragments, the growing point was also removed with the cotyledons. It was found that cotyledons supplied all the necessary material for root and leaf emergence in the first 48 hours so that in (i) many of the tissues failed to develop roots and it took much longer time for the emergence of the first leaf and root, while the tissues of (iii) and (iv) were similar to the tissues with both cotyledons intact (controls). Where only one cotyledon was removed it was observed that even the one remaining cotyledon served to supply the necessary material for root and leaf initiation. The growth elongation of tissues was best in those with cotyledons intact and decreased in the expected order according to the number of cotyledons and period for which they remained attached.

This work was carried out in connection with the Scheme of Plant Physiology and Cytology financed by the Indian Council of Agricultural Research, New Delhi.

138. Effect of Vitamins B_1, B_5, B_6, Glycine and of Gibberellic Acid and Potassium Nitrate on the Growth and Development of Apical Fragments of Mustard T. 102 Seedling Hypocotyls.

B. SEN and G. VERMA, Almora.

2 mm. apical fragments of mustard T. 102 seedling hypocotyls (length 12±1 mm.) were grown for 2 weeks in (i) GDW, (ii) vitamin B_1 (Thiamine hydrochloride) 1 ppm., (iii) vitamin B_5 (Nicotinic acid) 5 ppm., (iv) vitamin B_6 (pyridoxine) 1 ppm., (v) glycine 30 ppm. and (vi) in a mixture of vitamins B_1, B_5, B_6 and glycine. It was found that the first leaf appeared first in treatments, (ii) and (vi); roots emerged significantly earlier in (vi) than in others; the growth elongation of tissues was maximum in treatment (vi) followed by (v) and similar in (ii), (iii) and (iv). Plants raised from tissues grown in (vi), (iii) and (ii) showed significant earliness in flowering, but the leaf stage at which the flowers appeared was lower only in treatment (vi).

2 mm. apical fragments of 15±1 mm. hypocotyls of mustard T. 102 were grown for 2 weeks in (i) GDW, (ii) GA 50 ppm., (iii) GA+vit. B_1 1 ppm., (iv) GA+vin. 5_5 5 ppm., (v) GA+vit. 6_6 1 ppm., (vi) GA+glycine 30 ppm., (vii) GA+vitamins B_1, B_5, B_6 and glycine and in (viii) GA+ White's nutrient solution. Roots emergence was early oin in (viii). Compared to GDW all treatments induced significantly increased hypocotyl lengths but only treatments (vii) and (viii) induced better growth than GA. GA significantly suppressed root growth and the addition of vitamins B_1, B_5, B_6 and glycine only neutralised this effect to varying degrees. Only in treatment (vii) and (viii) significantly greater root growth was observed. Earliness in flowering was induced by treatments (iii), (vii) and (iv).

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These studies were carried out in connection with the Scheme of Plant Physiology and Cytology financed by the Indian Council of Agricultural Research, New Delhi.

139. Effect of Gibberellic Acid and Gibberellic Acid Like Subtances on the Growth Elongation of Pollen Tubes II.

B. SEN and G. VERMA, Almora.

The effects of incorporating in the germinating medium gibberellic acid (GA) with 5 amino-acids and 2 phenoxy compounds and GA like substances isolated from potato sprouts on the growth elongation of pollen tubes of Madonna lily (*Lilium condidum*) and of Sweet pea (*Lathyrus odoratus*) were observed.

GA + Amino Acids : Madonna lily pollen tubes were grown for 4 hours in (i) 12·5% sucrose solution containing, (ii) GA 0·1 ppm., (iii) Lysine 7·5 ppm., (iv) GA + Lysine, (v) Citrulline 10 ppm., (vi) GA + Citrulline, (vii) Cystine 50 ppm., (viii) GA + Cystine, (ix) Arginine 0·025 ppm., (x) GA + Arginine, (xi) Glutamic acid 0·025 ppm. and (xii) GA + Glutamic acid. Compared to the growth in (i) 720 microns, best growth elongation of pollen tubes was induced by (xii) 1890 microns, (iv) 1834 microns and (x) 1824 microns, followed by (xi) 1610 microns followed by (vi) 1414 microns, (ix) 1356 microns, (viii) 1314 microns, (iii) 1288 microns followed by (ii) 1024 microns, (v) 1064 microns and (vii) 908 microns.

GA + Phenoxy Compounds : Compared to the growth elongation of Madonna lily pollen tubes in (i) control medium, 998 microns, that induced in 5 hours by 12·5% sucrose solution containing, (ii) GA 0·1 ppm. was 1664 microns, (iii) 2, 4-D 1 ppm., 1398 microns, (iv) GA + 2, 4-D 2326 microns, (v) TIBA 0·5 ppm. 1196 microns and (vi) GA + TIBA 1864 microns.

Gibberellic acid like Substances : 1/50,000 water extracts of fresh sprouts of Potato tubers, containing gibberellic acid like substances induced significantly increased elongation of Sweet pea and Madoma lily pollen tubes. Compared to the length of Sweet pea and Madonna lily pollen tubes in control germinating medium, 604 and 1100 microns, the lengths of pollen tubes induced in 6 hours in 12·5% sucrose solution containing GA 0·1 ppm. were 738 and 1388 microns and in media containing 1/50,000 extract of potato tubers 884 and 1898 microns respectively.

These studies were carried out in connection with the Scheme of Plant Physiology and Cytology being financed by the Indian Council of Agricultural Research, New Delhi.

140. Germination and Growth of Madonna Lily Pollen Stored for One Year in Deepfreeze.

B. SEN and G. VERMA, Almora.

Madonna lily (*Lilium candidum*) pollen grains were stored in deepfreeze at −15 to −10°C. in glass and polythene vials and in butter paper packets sealed with scotch tape and kept in tightly stoppered conical flasks with or without $CaCl_2$. The pollen grains stored without $CaCl_2$ gave the best results, and some pollen grains germinated even after one year's storage in deepfreeze and showed satisfactory growth elongation.

One year old pollen grains were grown in sucrose-agar media (12·5% sucrose solution containing 1% agar) contaning (i) GA 0·1 ppm, (ii) citrulline 10 ppm., (iii) GA + citrulline, (iv) lysine 7·5 ppm., (v) GA + lysine, (vi) glutamic acid 0·025 ppm., (viii) GA+glutamic acid, (viii) cystine 50 ppm. and (ix) GA+cystine. Compared to germination of controlmedium , the germination induced by (ix) was 13·7%, (vii) 9·9%, (viii) 8·5%, (vi) 6·8%, (v) 6·0%, (iv) 4·3%, (iii) 3·8%, (ii) 3·7% and (i) 3·5%. Maximum growth elongation of pollen tubes was induced by (ix)

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followed by (v), (i), (iii), (viii) followed by (vii), (iv) followed by (ii), (vi) and by control.

One year old pollen grains were grown in 12·5% sucrose medium containing (a) GA, (b) GA + citrulline, (c) GA + cystine, (d) GA + 2, 4-D 1·0 ppm. and (e) GA + TIBA 0·5 ppm. Compared to 2·1% germination in control medium, that in cystine + GA was 8% and in other treatments between 3 and 4%. Maximum growth elongation of pollen tubes was induced by GA+ cystine and by (a), (b), (d) and (e) followed by control.

These results emphasize the role of cystine in the germination and growth of stored pollen of Madonna lily.

These studies were carried out in connection with the Scheme of Plant Physiology and Cytology financed by the Indian Council of Agricultural Research, New Delhi.

141. Effects of Gibberellic Acid on Flowering of Mustard T. 102 Plants Grown in Autumn, Winter and Summer.

B. SEN and G. VERMA, Almora.

Plants of mustard T. 102 were sown in pots in autumn (October 11, 1960), winter (December 12, 1960) and spring (February 21, 1961). Effects of spraying the seedlings every week from the age of 2 weeks with 100 ppm. GA on the vegetative phase of plants were observed. In autumn sown plants, which grew and matured in falling temperatures, only the plants receiving the treatment from 2 weeks onwards (10 spraying in all) showed significant earliness in flowering by 5·2 days, while those receiving the treatment from the age of 4, 6 and 8 weeks flowered late.

In winter sown series, the effects of spraying plants from the age of 2, 3, 4, 5, 6, 7 and 8 weeks were compared with others receiving the treatment from 2 weeks onwards, where the spraying was stopped in different pots after the first, second, third, fourth, fifth and the sixth spraying. It was found that GA treatment is effective when given early to plants, so that the treatment which was given all the spraying and treatment which received only the first two sprayings induced similar earliness in flowering. Later sprayings only helped to maintain increased height.

In plants sown in March, which matured under conditions of high temperatures, none of the treatments induced any earliness in flowering. The treatment receiving all the spraying only showed increased height.

Vernalisation Experiments : Seeds of mustard T. 102 were vernalised for 3 weeks in October, 1960 in (i) GDW, (ii) 50 ppm. GA, (iii) GA + KNO_3, (iv) GA + B, (v) GA + IAA and (vi) GA + Nutrient solution and were sown in field plots. Compared to plants from seeds of treatments (i) those from (ii) to (vi) showed cignificant earliness (at 1% level) and flowered at a lower leaf stage.

The experiment was repeated in March, 1961, when fresh seeds were vernalised in same solutions and the seeds sown in fields, no earliness in flowering was obtained.

These results show that GA treatment is only effective when given during the winter months and not in summer.

These studies were carried out in connection with the Scheme of Plant Physiology and Cytology financed by the Indian Council of Agricultural Research, New Delhi.

142. Growth periodicity in Roots of *Tilia europaea* L. seedlings.

D. N. SEN, Prague.

There is no fixed seasonal periodicity for the formation of new roots in Lime, the growth depends prevailingly on external conditions. The growth in long and

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short root is not directly related to the shoot growth. The different soil conditions very much influence the formation and growth of long, short and mycorrhizal roots. Under moist and warmer climate the root growth is enhanced. Dry conditions very much inhibit the new root growth, so this periodicity appears to be mainly due to ecological factors. The new root growth in sandy oil starts in the last, whereas in humus and loamy soils it is earliest and continuous for a longer time. In the month of May and June the growth was observed to be at peak, which falls down in July.

Mycorrhizae are nothing but short fungal associated roots, without which the life span of them is much shortened. The infection of short roots take place in two stages. Primary infection is the external colonization of short roots forming an ectotrophic mantle, and the secondary infection is carried from older part of the mycorrhizae to the newly grown prolongation so that the hyphae project from inside towards outside in the form of setae around the whole newly grown portion, which is delimited by notch. If the infection for a new uninfected short root is of secondary nature then setae-like hyphae project all around the whole root and not at the apex alone. The misinterpretation of long and short roots have been the major cause of the confusion in younger stages of the roots. The infection in *Tilia europaea* has never been observed in thick long roots, and hence it is concluded that infection may be carried on from mycorrhizal roots to new short roots than from long roots to short roots, as a secondary infection. Primary infection of short roots is always from outside by colonization of fungi on the root surface.

143. Observations on the Root Ecology of *Tilia europaea* L. seedlings.

D. N. SEN, Prague.

Lime seeds are enclosed in a fruit having a hard pericarp which is impermeable in water and air, unless it breaks and rots, the germination is difficult. Normally the seeds have a dormancy of 2-4 years. It is also seen that seed setting in the fruits is also poor. Germination is of epigeal type and is quite slow. The embryonic leaves are entirely different from the next pair of leaves, which remain attached on the seedling for quite a long time. So in a dry and sandy locality the natural regeneration of lime is difficult.

The primary root has an apex from 0·5-0·8 cm in length and a root hair zone, next to which is the zone elongation having dying hairs. The hypocotyl turns red-brown and its elongation is distinct. There is a great tendency of the development of lateral roots if the primary tap root is destroyed, and so the establishment of young seedlings is only possible if the surface layers of soil have enough moisture. This may be considered an important factor in transplantation of seedlings together with shade.

The root apex has distinct histogens in the thick roots in comparison to thin roots or primary tap root. The plerome, periblem and peripheral part including columella are distinct. The origin of lateral roots is from pericycle which takes the similar pattern as the normal root apex.

144. Effect of Ionizing Radiation on the Germinability of Jute Seeds.

SUBIR SEN and K. T. JACOB, Barrackpore.

Two different types of radiation e.g. 50 Kv X-rays (dosages ranging from 20,000r to 100,000r) and gamma rays (from radio-cobalt source of World Agric. Fair, New Delhi, 1959—dosages ranging from 40.000r to 00,000r) were used to irradiate dry seeds of JRC 212 (*Corchorus capsularis*) and JRO 632 (*C. olitorius*).

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Germination experiments with the seeds irradiated at different dosages reveal that :

(a) Only swelling of the seeds takes place without any sign of germination at dosages 140,000r to 200,000r of gamma rays.

(b) Small radicle only or radicle and plumule appear, followed by substantial necrotic killing of the seedling of JRC 212 and JRO 632 respectively at dosages 120,000r and 100,000r of gamma rays, and

(c) The cotyledons appear, but greatly reduced in size or curled. Seedlings at this phase may recover and give rise to plantules with the first vegetative leaf if the dose is sublethal e.g., 100,000r of X-rays for both the strains and 80,000r gamma rays for JRC 212.

LD^{100} for gamma rays appears to be located at 100,000r in case of JRC 212 and 80,000r in case of JRO 632, while LD^{50} is located near 60,000r in both the strains. For X-ray treatments the LD^{50} has been found to be located near 80,000r in JRC 212 and 60,000r in JRO 632, whereas LD^{100} appears to be beyond 100,000r in both the strains.

145. On the effect of sound-waves on the germination of seeds and the growth of seedlings in Certain Cotton varieties.

S. SHANMUGHASUNDARAM and K. S. THIRUMALAISWAMY,
Annamalainagar.

Even though much work has been done on cereals, pulses, oil-yielding and tuber-plants under sound excitation, no work so far has been done, on the effect of sound waves on the germination of seeds and growth of fibre-yielding-plants. In the present investigation a preliminary sttudy was therefore, undertaken to know the effect of sound-waves produced by an electrically-run tuning fork, on germination and growth of three varieties of cotton, namely, two varieties of American cotton *Cambodia* and one Asiatic cotton *Karunkanni*. All the three varieties showed earlier germination under sound excitation when compared with the non-excited seeds. On the other hand the excited seeds complete their germination earlier by at least four hours than the control.

Sound excited seedlings are able to grow better and their rate of growth is on an average 36% greater than the control.

Besides, the experimental seedlings had better developed and more profuse root-system than the control ones.

146. Effect of carbon and nitrogen sources on the production of a fungistatic substance produced by a species of *Fusarium* active against *Zygorrhynchus*.

N. P. SINGH and K. C. BASU CHAUDHARY, Agra.

A *Fusarium* sp. has been reported by Singh and Sinha (1962) to have antagonistic affect on a species of *Zygorrhynchus*. This paper deals with the effect of carbon sources (xylose, arabinose, glucose, fructose and lactose) and nitrogen sources (ammonium nitrate, potassium nitrate, alanine, acetamide and urea) on the production of the active substance.

Results indicate that *Fusarium* sp. can utilize in varying degrees all the carbon sources employed in the experiment. Of all the carbon sources, lactose gives the greatest zone of inhibition (10·6 mm.). This sugar is followed by arabinose (10 mm.), zylose (10 mm.), fructose (9·3 mm.) and glucose (6·6 mm.). As lactose was found to be the best source of carbon, its effect in different concentrations (2%, 3%, 4%, 6%, 8%, and 10%) on the production was also studied and it was

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observed that with the rise in lactose concentration from 2% to 4%, there was also a rise in the production of the active substance. On further rise is lactose concentration, there was gradual decrease in the production.

Of all the nitrogen sources tested, potassium nitrate gave the maximum zone of inhibition (14·3 mm.). This is followed by urea (13·0 mm.), ammonium nitrate (10·6 mm.), acetamide (8·6 mm.) and alanine (7·5 mm.). When the effect of different concentrations (0·238%, 2%, 4%, 6%, 8% and 10%) of potassium nitrate on the production of the fungistatic substance was studied, it was observed that the optimum result was obtained at 2% concentration and there was decrease in the production on either side.

147. Localization of Acid Phosphatase in Ovules of *Tropaeolum magus* L.

S. P. SINGH, Agra.

Huge outgrowths from the suspensor of the embryo have been reported and are referred to as suspensor and placental haustoria. The localization of acid phosphatase in the fertilized ovules of *T. majus* has been undertaken to determine the role of these haustoria in the development of the embryo.

In the beginning, in all the cells of the proembryo the enzyme is mostly localized in their nuclei but after the differentiation of the suspensor, the enzyme is discernable in the nuclei of the embryonal cells only. At this stage, in the endosperm the test shows the richness of enzyme in both the cytoplasm as well as in the nuclei. The chalazal and the micropylar portions of the endosperm which are deeply lobed are comparatively more rich in phosphatase than other portions of the endosperm. It, therefore, appears that the micropylar and the chalazal regions of the endosperm actively absorb those substances which are associated with the activity of acid phosphatase.

At a slightly later stage of growth the suspensor produced haustoria from its micropylar end. The cells of these haustoria are elongated and twisted and are in contact with the vascular tissue of the placenta probably to absorb food material directly from the placenta for the growing embryo.

148. On the effect of sound waves on alcoholic fermentation.

T. C. N. SINGH, Annamalainagar.

Experiments were first conducted in the laboratory on the budding of yeast cells under excitation of the sound waves of an electrically operated buzzer. It was noticed that the activity of budding was very much more accelerated in cases wherever the sound excitation had been dosed.

Subsequently experiments were directed to examine alcoholic fermentation under the excitation of similar sound waves and it was curiously found that the alcohol yield had shot up to about 60% more over the control.

Thereafter, experiments were translated on commercial scale by exciting 2 hours daily a whole vat of fermenting molasses solution for a period of 3 days. The total hours of excitation during this period was therefore only 6 hours. After distillation it was found that the experimental vat had yielded alcohol to the extent of 84 velts whereas in the control it was only up to a maximum of 80 velts. This may be considered as a preliminary experiment under commercial scale. Even then the increased output of alcohol by 5% over the control has been found to be very significant. These experiments were further repeated with ample consistent confirmations. In term of money it may be disclosed that this increase of 5% would add about one lac of rupees annually to the income of a small distillery having fifteen fermenting vats.

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Planning is still going on to secure these experiments on a much better and more efficient line of investigation by installation of electrically operated equipments for producing more harmonious sound throughout the fermenting liquor. My grateful thanks are due to Shri C. Saravanaperumal, Manager, Government Distillery (Pondicherry) for his very close co-operation in conducting these experiments.

149. Further studies on the effect of sound waves of *Nadeshwaram* on the growth and yield of paddy.

T. C. N. SINGH and A. GNANAM, Annamalainagar.

This paper embodies results of the past four crop years' experiment, beginning from 1956 on the effect of sound waves on the growth and yield of paddy at Sirkali. The first experiment however in this line was executed in early 1956, at Chidambaranathan pettai with the original musical sound of violin, but subsequently it was translated at Sirkali where a recorded music of *Charukesi raga* piped through *Nadeshwaram* was broadcasted to the field through loudspeaker. The variety used in successive years were CO-25, ADT-7, ADT-9 and CO-25 and the yields obtained in each year respectively were found to be 52%, 60%, 42%, and 36% more in the excited experimental plots as compared to their controls. Even when the yields of the experimental plots were compared with the maximum yielding capacity of plot during the preceeding 10 years, it was 60% higher on an average.

Periodical observations were taken on the height of the plants, number of tillers per clump, length of the spike, number of grains per spike and yield per cent and they have been statistically calculated and in each case it was found that the differences were highly significant in favour of the experimental.

In all such cases where observations were taken from the beginning, it was found that the differences in height were not significant in the beginning, but after one week it became significant at only 5% level and not at 1% level. But as the excitation continued it became significant at both the levels viz. 5% and 1% after 2 weeks.

These experiments carried during these four years have definitely shown without any shadow of doubt that sound-waves do affect salubriously the growth and yield of paddy crops.

150. Observations on Bio-chemical analysis of sugarcane under the excitation of sound-waves.

THAKURJI SURAJNARAIN SINGH, Sewagram.

It is well established that sound excited plants exhibit better growth, flower earlier and yield more than non-excited plants. The present study was undertaken to know the effect of sound waves on bio-chemical changes in plants. In experiments done at Abishekapakkam (Pondicherry), the sugarcane variety CO. 527 showed better vegetative growth under the excitation of broadcasted music.

Biochemical analyses of mother canes of both the experimental and control (obtained from the Abishekapakkam) were done in two periods. First analysis was done when the canes were nine months old and the second analysis was done when they were twelve months old. There is not much difference in dry weight between control and experimental in both the analyses. There is, however, a definite increase in the total sugar in the experimental plants. Cellulose content is more in control than in the experimental.

When the canes were 9 months old, C/N ratio is greater in control than experimental. After a period of 3 months, C/N ratio rose to 29% more than the control

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in the experimental plants. Therefore, it is clearly proven that bio-chemical changes do take place under the excitation of sound waves.

ECOLOGY AND FLORISTICS

151. An imperfectly known endemic Taxon of Kumaon Himalayas— *Falconeria himalaica* Hook f. *(Wulfenia himalaica)* (Hook. f) Pennell.

T. ANANDA RAO, Calcutta.

During a botanical exploration in the Kumaon Himalayas complete specimens of *Falconeria himalaica* Hook. f. were collected at Kalamuni pass at an altitude of 3000 meters. The rediscovery of this taxon is of interest because of its incomplete description and dubious systematic position. The present paper gives a detailed taxonomic description of this taxon.

152. Preliminary report of the Vegetation of Rameshwaram island with special reference to Sand dunes flora and habitat.

T. ANANDA RAO, Calcutta.

The paucity of information on coastal sand dunes and plant communities, especially in India, emphasises the importance of ecological studies in solving sand drift problem. Intense ecological relations of plant communities of Sand dunes are of special interest in view of their role and Sand binders and stabilisers of the mobile dunes.

The vegetation of Rameshwaram island is typically that of dry tropical umbrella type of scrub forest as it is seen in the nearest mainland of Ramnad district. The island vegetation distinctly falls into two regions. The Northern hump and the Southern sandy bleak area are very much different from one another in aspect and configuration of the vegetation. Their features are distinguished sharply with edaphic features and dominant plant communities in this preliminary report.

The vegetation of the Northern hump can be distinguished into strand and inland vegetation whereas the Southern area into Mangrove, strand and sand dune vegetation. The characteristic scrub type of vegetation of Northern zone is no longer present in the Southern zone, especially towards deep south the vegetation is completely absent. The chief factor for the destruction of the pre-existing flora is the prevailing strong desiccating wind that blows from April to November causing sand drift.

A close observation of the island flora revealed that in the recent past the Northern hump must have thick open scrubby formations with the principal constituent of *Acacia planifrons* and the Southern part of the island, which is now nothing but a sandy waste must have once borne a good cover of sedges.

The soil is mainly sandy varying in texture from very fine to fine and coarse mixed. Either they do not contain any organic matter or very little in the form of undecomposed small roots and leaves. Only soils from the slack moist belt and ant-hill zone in the Northern hump of the island are clayey sands with good water holding capacity. The slack soil contains a little undecomposed organic matter and ant-hill soil contains sufficient decomposed organic matter. The pH variation of Southern zone soils is narrow comparatively and it is wider in the soils of Northern zone and the lower limit of 7·2 pH here approaches the neutral. Calcium content of the soils of Northern zone is generally lower than in the soils of Southern zone. Chlorides in all the soils are high. Nitrate nitrogen contents of any significant value are either in the soils of slack belt in both the portions of the island or in

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the mangrove belt. It is highest in the ant-hill soil where there is a thick scrubby vegetation. Potash and phosphorus contents of all the soils are more or less the same.

153. Plant abnormalities from the Indian Desert.

M. M. BHANDARI, Jodhpur.

During studies on the flora of the Indian Desert, the following abnormalities have been observed in the local plants :

Proliferation of the flower :

Tephrosia purpurea Pers., *Tephrosia strigosa* (Dalz.) Santapau and Maheshwari, *Pedalium murex* Linn. and *Argemone maxicana* Linn. In both the species of *Tephrosia* instead of a normal carpel a pinnate compound leaf developed while in some other cases a leaf-like structure similar to the terminal leaflet of *Tephrosia purpurea* Pers. and the normal leaf of *T. strigosa* (Dalz.) Sant. & Mahes. arise. Proliferation of the flower and malformation of the .oral parts also occur in *Helianthus annus* Linn. and *Oscimum basilicum* Linn. both being garden plants.

Fasciation of the stem :

Euphorbia caducifolia Haines, *Leptadenia pyrotechnica* (Forsk.) Dine. and *Cocculus villosus* DC.

Fasciation of roots :

In the young plants of *Crotalaria burhia* Ham. growing on sand dunes.

Fasciation of inflorescence axis :

In cultivated *Cassia fistula* Linn. fasciation of peduncles and pedicels of the flowers has been observed.

Double carpels :

In *Cassia auriculata* Linn. the occurrence of bicarpellary apocarpus condition has been found more than once.

154. New Plant records for N. W. Indian Desert.

M. M. BHANDARI, Jodhpur.

During the course of study of Indian Desert plant for some years past, about 100 species of the plants have been collected from N.W. Rajasthan Desert which have not hitherto been reported from this area. Of these about 50 plants which have been finally determined, are listed below. Many of these plants are common in the adjacent areas. Some of these new records are of the plants which have been wrongly identified in the past like *Euphorbia caducifolia* Haines, *Indigofera astragalina* DC., *Flaveria australasica* Hook., *Tribulus cistoides* Linn., *Tephrosia fulciformis* Ramaswami and *Withania coagulens* Dunal. Some plants like *Acanthospermum Hispidum* DC., *Martinia annua* Linn., *Dentella repens* Frost., *Justicia heterocarpa* T. Anders. and *Ipomea muricata* (L.), Roth. appear to be new in the area. Following is the list of new records family wise :

ACANTHACEAE : *Barleria cristata* var. *dichotoma* Prain, *Hygrophylla polysperma* T. Anders., *Justicia heterocarpa* T. Anders.; ASCLEPIADACEAE : *Ceropegia bulbosa* Roxb., *C. bulbosa* var. *lushii* Hook., *Dregea volubilis* Benth. ex. Hk. F.; CAESALPINEAE : *Cassia obtusifolia* Linn. & *C. occidentalis* Linn.; CAPPARIDACEAE : *Maerua arenaria* (DC.) Hook. F. & Thoms.; COMBRETACEAE :

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Anogeissus coronata Starf.; COMPOSITAE : *Acanthospermum hispidum* DC., *Flavoria australasica* Hook., *Gnaphalium indicum* Linn., *G. purpureum* Linn. and *Pluchea wallichiana* DC.; CONVOLVULACEAE : *Cuscuta chinensis* var. *ciliaris* Engelm., *Ipomea coptica* (Linn.) Jacq., *I. muricata* (Linn.) Roth. R. & Set., *I. nil* (Linn.) Roth., *I. pilosa* Sweet., *Merremia dissecta* (Jacq.) Hallier, *M. quinquefolia* (Linn.) Hallier; EUPHORBIACEAE : *Euphorbia caducifolia* Haines, *E. heterophylla* Linn. and *Securinegea virosa* (Roxb.) Pax. et Hoffm.; LILLIACEAE : *Urginea indica* (Roxb.) Kunth.; MALVACEAE : *Althea ludwigii* Linn., *Hibiscus lobatus* (Murr.) O. Ktze., *H. punctatus* Dalz. and *Malvastrum coromandelianum* (Linn.) Garcke.; MARTINIACEAE : *Martinia annua* Linn.; ONAGRACEAE : *Jussia perenis* (Linn.) Brenan; PAPILIONACEAE : *Indigofera astragalina* DC., *Rhynchosia aurea* DC., *Tephrosia julciformis* Ramaswami, *Trigonella occulta* Del. ex DC. and *Zornia diphylla* (Linn.) Parsoon; PORTULACACEAE : *Talinum paniculatum* (Jacq.) Gaertn.; RUBIACEAE : *Dentella repens* Forst.; SCROPHULARIACEAE : *Bacopa monnieri* (Linn.) Pennell, *Kickxia ramosissima* (Wall.) Janchen., *Veronica agrostis* Linn. and *V. anagalis* Linn.; SOLANACEAE : *Withania coagulens* Dunal.; TILIACEAE : *Triumfetta brartramia* Linn.; ZYGOPHYLLACEAE : *Tribulus cistoides* Linn.

155. Floristic composition of some chir (Pinus roxburghii) forests of India.

H. P. BHATNAGAR, Dehra Dun.

Chir (*Pinus roxburghii*) forests are found to occur in the outer ranges and principal valleys of the Himalaya and on the ridges of the Siwalik hills. Chir forests are flanking the Himalayas from 1,5005 to about 7,500', and occasionally higher. An attempt has been made in this paper to give some account of the important flora of some chir forests of India, as also their spatial distribution. For this purpose the collection of species were made during the phytosociological studies of some chir forests of India. These studies were conducted in Jammu & Kashmir, Punjab, Himachal and Uttar Pradesh in various forest divisions. Floristic and structural studies of these forests revaled an assemblage of about 180 species belonging to 57 families. Their spatial distribution was carefully recorded in terms of phytosociological attributes (rare, occasional, common and abundant) to work out their dynamic tendencies in due course.

These studies have revealed that though chir is typically a gregarious tree, forming pure forests of considerable extent, it is often mixed with other species. In its natural zone it is associated with the following tree species, *Pyrus pashia, Sapium sebiferum Mallotus phillipensis, Litsaea umbrosa. Olea cuspidata, Ficus roxburghii, Celtis australis, Xylosoma longifolia.* The common shrub species are, *Carissa opaca, Inula cappa, Indigoferra pulchella, Mimosa rubicaulis, Randia tetrasperma, Flemingia fruticulosa, Jasminum arborescens, J. humile, Dodoanea viscosa, Myrsine africana, Rosa muschata, Leea romusta, Murraya koenigii, Hypericum cernum, Thamnocalcamus aristatus, Berberis lycium, Lespedeza sericea Lonicera quinquelocularis, Prinsepia utilis.* The common species of herbs are *Dicliptera bupleuroides, Justicia simplex, Oxalis corniculata, Oplismenus compositus, Cassia tora, Alium sp, Urena lobata, Sida veronicaefolia, Fragaria indica, Adiantum sp., Asplenium sp., Micromeria biflora, Hemegraphic latebrosa Blumea oxyodonta, Souchus aryensis,* and *Vernonia roxburghii.* Common climbers are *Rubus Saniculaus, Smilax aspra, Cayratia carnosa, Ichnocarpus frutescens.* Towards its upper limit its common companions are *Cedrus deodara, Pinus wallichiana, Quercus incana, Rhododendron arboreum, Pieris ovalifolia, Myrica nagi.* Towards the lower limits chir is associated with, *Shorea robusta, Anogeissus latifolia, Ougeinia dalbergioides, Buchanania lanzan, Bauhinia retusa, B. variegata.* In dry and open places at lower elevations *Euphorbia royleana* is the common shrub. In

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many chir forests at elevation higher than 4,000 ft. and over the undergrowth consists of a shrubby growth of *Rhododendron arboreum* and *Pieris ovalifolia*.

156. Vegetation cartography of south and north districts according to the method of gaussen.

M. V. DABHELKAR, Bombay.

In the present work, an attempt has been made to map out the vegetation of South and North Arcot districts using Gaussen's method.

This method has been applied for the first time in India at the scale of 1 : 253,440. The first map at the scale of 1 : 1000,000 of South India up to 12° latitude had already been prepared by Gaussen and his co-workers (1961).

The following features have been shown on the map :

1. Natural vegetation or the forest types.
2. Introduced vegetation.
3. Irrigation.

1. Natural vegetation is divided into four types of which two are climatic and two are edaphic. The edaphic types are the strand and Mangrove vegetation and are represented by red dets and violet lines respectively. Both the edaphic types are located in coastal zone. The climatic types viz. the series of *Albizzia amara* and *Acacia leucophloea* and the series of *Tectona grandis* and *Terminalis* sp. are shown by orange and yellow colours respectively. The physiognomy and the existing conditions of the forests are depicted with different symbols.

2. Introduced vegetation is divided into two parts viz. cultivations of cereal crops and the plantations of the trees. The main crops in the districts are paddy, millets, groundnut, pulses and sugarcane. The plantations are of *Casuarina equisetifolia, Anacardium occidentale, Mangifora indica, Coces munifora* and Betel vine.

3. Irrigation is by dams, channels, tanks and reservoirs.

Apart from the main map of vegetation, Inset maps at scale at the scale of 1 : 1000,000 are also shown and these are as follows :

A. Map of survey sheets at 1 : 1 mile.
B. Plesioclimax map.
C. Soil map.
D. Geological map.
E. Map of administrative divisions.
F. Bioclimatic sap.
G. Map of Agriculture.
H. Map of Xerothermic indices and Hypsometry.

Therefore, the above studies show that the tropical vegetation can be mapped out successfully at the scale of 1 : 253,440 according to the method of Gaussen.

The International map at 1 : 1000,000 which is prepared by Gaussen and his co-workers gives only a general idea about the vegetation types while the present districts maps being at larger scale i.e. at 1 : 253,440 (or 1 : 4 miles) show detailed information on the vegetation types.

In India, therefore, the mapping of the vegetation should be carried out district-wise at the scale of 1 : 253,440 or even taluk-wise at the scale of 1 : 63,360. The scale such as 1 : 1000,000 is of little use to our country as it gives only the general outline of the vegetation of the region.

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157. Succession of vegetation in south and north Arcot districts.

M. V. DABHELKAR, Bombay.

The succession of vegetation in South and North Arcot districts has been traced and is presented in this paper.

It was shown that—

In the plains, cutting and grazing are very active and therefore most of the forests are in a very degraded condition. The Plesioclimax in these areas is formed by *Albizzia amara* and *Acacia leucophloea*.

The edaphic facies are *Memecylon edule* and *Manilkara hexandra* and they are conspicuous on soils which are derived from Cuddlore and sand-stone. The other facies viz *Euphorbia antiquorum* and *Pterolobium indicum* grew on soils which are highly leached, low in Exchangeable ions, and with gravels.

On the hills, the active biotic factors of burning cutting and grazing have also reduced the status of the original vegetation. The dry deciduous forests up to 1500 ft. which are dominated by *Anogoissus latifolia* is regarded as "Sub-climax" while the "Plesioclimax" consists of *Tectona grandis* and *Terminalia* sp. which are characteristic representatives of the Southern moist deciduous forests.

158. Climatic zones in relation to the forest types in south and north Arcot districts.

M. V. DABHELKAR, Bombay.

Champion (1936) has sought to explain the distribution of forest types of India in relation to climatic factors such as rainfall and temperature.

In the present work, the distribution of the forest types of South and North Arcot districts was studied in relation to rainfall, temperature, xerothermic indices, and dry period.

It was shown that—

The dry evergreen forests are restricted to $t^5\ r^2\ x^3\ d^3$ climatic zone while the pure thorn scrub forests are distributed in the remaining climatic zones formed by the combination of $t^5\ r^3\ r^4\ x^3\text{-}x^{3\cdot4}$ and $d^2\text{-}d^3$. This shows also that the thorn scrub forests have wide ecological amplitude and thus those forests are distributed all over the plain in the districts.

The distribution of the dry deciduous and moist deciduous forests is dependent on the elevation and consequently on climate. The best developed forests are situated in the climatic zones viz. $t^5\ r^1\ x^3\ d^2$ and $t^4\ r^2\ x^4\ d^1$.

159. Edaphic factors in relation to the forest types in south and north Arcot districts.

M. V. DABHELKAR, Bombay.

In this paper, the influence of edaphic factors such as Geology and soils on the distribution of the forests has been discussed.

It was found that—

The dry evergreen forests are characteristics of Cuddlere sandstones and are conspicuously absent from the ether geological formations. The other forest types viz. Southern thern scrub forests, Southern dry deciduous forests and Southern Moist deciduous forests are distributed irrespective of the geological formations.

On the red earths, the predominant forest type is the thern scrub forest in the plains and the Sevennah type of dry deciduous forest on the hills.

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Most of the thern scrub forest species grow well on acidic as well as on algaline soils. While the deciduous forest species prefer slightly alkaline soils.

Anegeissus latifelis, exhibits good growth on soils rich in exchangeable ions.

The results on the Organic matter show that the constituents of the forests soils depend upon the forest cover.

160. Plant records—I.

K. M. M. DAKSHINI, Derhadun.

During the extensive vegetational studies of Mothronwala Swamp, Forest many new plant species, new to the area have been collected. The present paper reports the occurrence of the following ten species not reported from Dehradun and its neighbourhood; *Viola canescens* Wall. (Violaceae); *Borreria ocymoides* DC. (Rubiaceae); *Adenostemma viscosum* var. *elata* Hook. f.; *Blumia lancelara* Druce; *Blainvillea acmella* (Linn. f.) philipson; *Echinops cornigerus* DC. (Compositae); *Lindernia hookeri* sub. sp. *kumaunensis* Pennell. (Scrophulariaceae); *Machilus oboratissima* (Wall.) Nees. (Lauraceae); *Curculigo orchioides* Gaertn. (Hypoxidaceae); *Gagea reticulata* Schultes. f. Brief notes, valid name etc. are given in the text.

161. An ecological study of the lac bearing trees (Butea monosperma) of 'Damda' Purulia P.S.

B. B. DAS, Purulia.

The area under review is 'Damda', a protected area under the supervision of the Directorate of Industries of the Government of West Bengal. It is the seed-lac producing centre of the State Government.

It is situated at approximately 23° 20' N latitude and 86° 23' E longitude. It occupies an area of 45 acres. The average altitude of the area is above 700 ft. above the sea level. The climate is of monsoon type with maximum summer temperature of 42°C in May-June and minimum winter temperature of 13°C in December-January. The annual rainfall is just over 50 inches mainly precipitated by the N-E monsoon.

The soil is poor and the soil texture varies from clay to sand. This is acidic to neutral and the soil pH from 5·9 to 6·8. The quantity of soluble salts present in the soil is normal (0·03% to 0·5%). The quantity of available nitrogen, phosphorus and potassium is found to vary from place to place. The nitrogen content of the soil is very low (90 to 210 lbs/acre). The phosphorus content of the soil is also very low (10 to 26 lbs/acre). But the potassium content is medium (160 to 300 lbs/acre).

The number of Palas (*Butea monosperma*) counted in the area is 4080 of which 2080 are full-grown trees having attained a considerable height of 15 ft. or more. The rest (2000) are all small plants and all of them are below 5 ft. in height.

The area covered by Palas (*Butea monosperma*) is about 25 to 30% of the total area of 45 acres. But the quadrat study gives a quite different picture. From the above study it has been found that Palas (*Butea monosperma*) occupies about 87% of the total area of 1000 sq. ft. of the 10 quadrats with minimum of 50% in quadrat No 1 and the maximum of 100% in quadrat Nos. 4,6.7. & 9.

The production of seed-lac is 4 to 5 seers per adult tree.

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162. "Some observations on the spore-forming bacteria associated with the silk-worm larva, Bombyx mori Linn."

R. K. GHOSH, Berhampore.

While studying on the normal alimentary flora of the silkworm larva, two spore-forming bacteria, viz. *Bacillus subtilis* and *Bacillus megaterium* were isolated.

Sawamura (1906) described *Bacillus megaterium* as pathogenis to silkworm, while Jameson (1922) isolated the same from the normal and diseased silkworm larvae.

Bacillus subtilis, though a common spore-forming species widely distributed in nature, is reported for the first time in association with the silkworm larvae.

163. Studies on the vegetation of Bhimashankar ranges and its surrounding areas of Khed Taluka.

K. P. JANARDHANAN, Poona.

Preliminary observations made on the vegetation of the Bhimashankar ranges and its surrounding areas of Khed taluka are presented in the paper.

The area studied lies within the longitude 73° 30′ 5″-74° 3′ 5″E and latitude 18° 37′ 1″-19° 17′ 4″ N on the north western part of the Deccan plateau and is comprised of undulating hilly country. A survey of the vegetation of the area indicates that it has five main types of vegetation—(1) Evergreen shola type, (2) Semi-evergreen type, (3) Dry deciduous type, (4) Scrub jungles and (5) Grasslands. The successional status of the different types of the vegetation and the factors affecting them have been discussed. 415 species of vascular plants belonging to 77 families have so far been studied with a view to prepare ultimately a Flora of Khed taluka. Out of these, the largest families with the number of species in each are Leguminosae (66 Sp.), Gramineae (31 Sp.), Compositae (26 Sp.), Euphorbiaceae (18 Sp.), Acanthaceae (16 Sp.), Labiatae (14 Sp.), Rubiaceae (10 Sp.), and Commelinaceae (10 Sp.). These 8 families represent nearly 50 per cent of the total flora of the area under study.

Dendrophthoe falcata (Linn. fil.) Etting., *Dendrophthoe trigona* (Wt. & Arn.) Danser ex Santapau, *Taxillus cuneatus* (Roth) Danser, *Macrosolen capitellatus* (Wt. & Arn.) Danser, *Scurrula philippensis* (Cham. & Schlecht.) G. Don., *Viscum articulatum* Burm. f. etc. are some of the tree parasites frequently found in the area. A root parasite commonly found is *Striga gesneroides* Vatke es Engler. Among the plants of medicinal importance generally found here, mention may be made of the following—*Argemone mexicana* Linn., *Azadirachta indica* Juss., *Boerhavia diffusa* Linn., *Cardiospermum halicacabum* Linn., *Cassia fistula* Linn., *Cynodon dactylon* Pers., *Hemidesmus indicus* R. Br., *Emblica officinalis* Gaertn., *Gymnema sylvestre* R. Br., *Pongamia pinnata* (Linn.) Pierre, *Terminalia chebula* Retz. etc.

Viscum articulatum Burm.f.var. *thelocarpum* (Danser) Seshagiri Rao, *Commelina subulata* Roth, *Cyanotis cucullata* Kunth, are some of the interesting new records from the area.

164. Additions to the flora of Mt. Abu, Rajasthan.

K. C. KANODIA and Miss U. R. DESHPANDE, Poona.

While preparing a comprehensive list of plants, collected during several explorations from Mt. Abu area in Rajasthan State more than seventy species of Angiosperms and Cryptogams have been found new to the area. Out of these the following is the list of the interesting species :

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Commelina kurzii, Erythrina stricta, Ficus lacor var. *wightiana, Galinsoga parviflora, Grewia glabra, Hemigraphis hirta, Indigofera subulata* and *Leucas biflora* var. *procumbens* have not been recorded also from Punjab, Rajasthan and Gujarat States.

Alternanthera repens, Clitoria biflora, Ficus lacor var. *wightiana, Indigofera subulata, Hemigraphis elengans* var. *crenata Vandellia nummularifolia, Silene concidea* and *Telanthera ficoidea* have not been recorded from Behar, Orissa, Bengal and Assam States also.

Alternanthera repens, Erythrina stricta, Hemigraphis elegans var. *ocrenata, Murdannia nudiflora, Sida glutinosa* and *Triumfetta annua* are not reported even from Uttar Pradesh.

Clitoria biflora, Hemigraphis hirta, Medicago dentiulata Silene conoidea, Stellaria media, Triumfetta annua and *Vandellia nummularifolia* have not been recorded from Kerala State.

Hemigraphis hirta, Indigofera subulata, Leucas biflora var. *procumbens, Silene conoidea* and *Stellaria media* have not yet been recorded from Maharashtra State.

Out of the Hepatio flora of Mt. Abu, *Anthoceros longii, Fimbriaria angustata, Plagiochasma intermedium* have not been reported previously.

Among the rich fern flora *Asplenium lumulatum, Athyrium hohenckerianum, Cheilanthes varians, Diplazium sylvaticum* and *Lastrea crenata* are the new records for the area.

Various details on the distribution, habitat of the new records for the area together with a comparative systematic list of the species are given in the paper.

165. Ranunculaceae in Assam and North East Frontier Agency (N.E.F.A.).

S. K. KATAKI and G. PANIGRAHI, Shillong.

After the publication of the "Flora of Assam" by Kanjilal, Das, *et al* (1934), the sporadic collection tours undertaken in the Abor hills (Burkill 1924), in the Aka hills (Bor 1938) and between the Foot hills and Bomdila (Srinivason 1960) have added valuable, though meagre data, to the Botany of Eastern India.

The exploration tours by the Eastern Circle of the Botanical Survey of India between 1955-1960 have yielded significant new data both on the vegetation and flora of the vast untrodden tracts of Assam snd N.E.F.A. (Rao and Panigrahi, 1961).

This paper presents an enumeration of 11 genera with 36 species of the family Ranunculaceae, collected during these tours, furnishes important notes on the habit and habitat of each species together with exact localities of occurrence and abundance in the areas and classifies in a tabular form, the altitudinal range of distribution of each species.

It appears that *Anemone rupestris* Wall (Sela—3000 m. Rolla 9663), *Caltha palustris* L. (Senzedzong 4600 m. Rolla 7794), *C. scaposa Hk.* f. & T. (Senzedzong 4600 m. Rolla 7741) and *Isopyrum adiantifolium* Hf & T (Chakoo 2900 m. Panigrahi 16084), are new records of species for Assam and NEFA and *Clematis acutangula* Hk. f. & T. and *Coptis teeta* Wall. turn up as endemic species to Eastern India. Whereas *Caltha* spp. and *Ranunculus hirtellus* Royle are restricted to temperate and subalpine altitudes, a few genera viz. *Anemone, Clematis* and *Ranunculus* are distributed over tropical, subtropical and temperate forests in the area. *Anemone rivularis* Ham., *Clematis gouriana* Roxb. are a few of the 10 species with widest distribution in the area and extend their range of distribution to the neighbouring countries e.g. Ceylon, Java, Philippines, America etc.

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166. The intruding weeds of the Nilgiris.

N. K. LAKSHMANAN, Annamalainagar.

The Nilgiris District is situated in a converging angle, where Mysore, Madras and Kerala States meet each other and where eastern & western Ghats merge with each other. It falls between the latitudes 10°1′N and 110°45′N and the longitudes 76°0′E and 77°15′E. Being a hilly district it has got a variety of species representing temperate, tropical and sub-tropical species.

An attempt has been made to focus the attention of Botanists towards the problems of the weeds of the Nilgiris. Reading the medicinal and economical values of the weeds, the author disagrees with the earlier definitions of weeds as "useless and waste plants"; and defints a weed as 'a plant, mainly herb or shrub, which grows by its own accord, in a place where it is not desired or where the hindrance by it is felt." For exuberance, dominance, endurance and migration, weeds have got at least some of the following characters. (1) Enormous out-put of seeds, (2) Greater viability of seeds, (3) Durability of seeds, (4) Special means in the dispersal of seeds, (5) Special means in the propagation of species, (6) any means to escape from Biotic factor and (7) suitable edaphic or climatic conditions. The weeds of the Nilgiris could be broadly classified into (a) weeds of the plantations, (b) weeds of the cultivated fields, (c) weeds of the road-sides and (d) weeds of the denuded forest areas, grasslands and other waste lands.

The commonest weeds, according to dominence, are (1) *Lantana camera,* (2) *Eupatorium glandulosum,* (3) *Oxalis spp,* (4) *Tridax spp.* (5) *Biden spp,* (6) *Helichrisum brachiliatum,* (7) *Cytisus scoparius,* (8) *Ulex europeaus,* (9) *Solanum giganlium,* (10) *Dodonea viscosa,* and (11) *Acacia dealbata.* The very striking and salient feature is that all the weeds are exotic species which were introduced to the gardens. Their escape from the gardens and becoming wild and predominating all over the Nilgiris is something notable. Upto recently *Eupatorium glandulosum* was the most dominating weed. Now the place has been taken up by *Lantana camera,* which is a latest addition. It is pitiable to note that *Helichrisum brachtiatum,* which is one among the beautiful and lovable garden plants, is becoming a dominating weeds. Hence, it is felt that it is worthwhile if a thorough Ecological study on the weeds of the Nilgiris is taken up.

167. Studies on the Angiospermic Hydrophytes of Patna.

MAHENDRA THAKUR, Patna.

As far as the author is aware no systematic account of the hydrophytes of Patna has appeared so far. Indeed some brief references to the hydrophytes of this place have been made by Haines (1926) and Srivastava (1956) but these descriptions are very meagre. Hence an attempt has been made to give a somewhat detailed account of the hydrophytes of this place.

Patna is situated at 25°-37′ north latitude and 85°-10′ east longitude. It is about 180 ft. above the sea level and the soil is chiefly sandy loam. It possesses a monsoon type of climate. The hot wet season is from the 15th June to 30th of September. The rain fall is about 48″ per annum, the heaviest portion in July and August. An interesting point noticed is that the rain fall has been gradually decreasing and has been very irregular, and most of the time it rains in torrents rather than in steady showers. The maximum temperature is 115°F in June and the minimum winter temperature is 36°F in January. The relative humidity is 51 in May and 86-87 in July-August. The summer temperatures have gradually been rising and the relative humidity falling so that there are signs of slow desiccation in the area.

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From the present studies of the hydrophytes of this locality following conclusions are made :—

(1) The dominant family, according to mere number of species, is Hydrocharitaceae.
(2) *Eichornia crassipes, Solms.* belonging to the family Pontederiaceae is the most dominating single species.
(3) In general aquatic monocots are more common than aquatic dicots.
(4) *Trapa bispinosa Roxb.* is the only species cultivated for its edible fruits and *Nymphoea* species are cultivated in the gardens for ornamental purposes.
(5) Forty seven hydrophytes belonging to 25 families are found in this locality.
(6) As there has been no previous account of the hydrophytes of this area, it is difficult to ascertain the number of newly introduced species, but it cannot be ruled out that some of them have been recently introduced due to changes in the climatic and biotic factors.

168. The weed flora of Darbhanga District (Bihar)—I. Paddy Field Angiospermic Weeds.

MAHENDRA THAKUR, Patna.

Darbhanga district is almost in the centre of North-Bihar and lies between 25°-28′ and 26°-46′ North latitude and between 85°-31′ and 86°-44′ East longitude. The entire district is wholly flat, devoid of hills unlike South-Bihar, and the soil is of alluvial type. The climate is of monsoon type with maximum summer temperature of 110°F to minimum winter temperature of 50°F and the average annual rain fall is approximately 45″. It is very much affected by the floods of rivers like Kosi, Kamala, Burhi Gandak and the Ganges. Paddy is the chief cultivated crop of this district.

A systematic account of the large number of paddy field weeds of this district has been put on the record for the first time. These weeds on systematic classification show that the dicotyledonous families are more in number than the families belonging to the monocotyledonous group, and the mnnocotyledonous families—Cyperaceae and Gramineae predominate over all other families in having large number of plant-species. The monocotyledonous families are more in number on medium and low lands than they are found on high lands. The dicotyledonous and monocotyledonous genera are almost equal in number, but the monocotyledonous species are more in number than dicotyledonous species. The preponderance of the monocotyledonous species may be assigned to the production of large number of seeds which are light in weight and easily dispersed both by air and water. As there has been no previously account of the Rice-field weeds of this district it is difficult to ascertain either the number of recently introduced species or the species which have been eliminated in course of time. Further studies on the weeds of this district are in progress.

169. Phytogeography of the genus *Stipa* L.

K. C. MISRA, Banaras.

Stipa is a sub-cosmopolitan genus including more than 350 species. The distribution pattern of various members of this genus, and evidence provided by fossil plants of Stipoideae from North America, shows the antiquity of the taxan. The present investigator has made a phytogeographic study of the genus, and the lines of evidence, from the areal pattern of distribution, from the morphological, cytological and ecological studies, suggest that the genus evolved in a southern land

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mass, occupying the South Pacific Region. The study has indicated that from this geological land mass, *Stipa* migrated northward along two channels. On these routes, four secondary centres of development were established and the modern Stipas migrated from these centres.

This involved migration to North America from South America, which is contrary to the existing belief that *Stipa* is of northern origin and migrated into North America from Asia by way of Alaska (Clements 1920, Beetle 1957).

170. Edaphic Conditions and Pond Vegetation.

H. P. MEHTA, Varanasi.

The substratum of the temporary ponds of Varanasi remains covered with water for nearly four to eight or nine months according to depth, following July each year. These low-lying areas present a heterogenous environment due to differences in size and period for which they retain water.

It has now been well stablished that aquatic plants and more particularly rooted aquatics depend on the substratum for their nutrients. The relation between growth, distribution and behaviour of plants, in both dry as well as aqueous phases of ponds, and the physico-chemical properties of substratum are studied.

From March to June these ponds remain dried up and plants characteristic of this phase appear. Profile study of the substratum has been made. Samples from different depths are quantitatively analysed by volumetric, flame photometric and spectrophotometric methods.

The vegetation is interpreted in terms of topographic differences and variations of ionic concentration of exchangeable Na, Ca, K, Mg, CO_3, NO_3, Organic matter and pH. The correlation between zonation and behaviour of vegetation and spatial and temporal changes in physico-chemical characters of substratum have been established.

171. Some observations on the morphology and biology of *Cleome chelidonii* Linn.

M. V. MIRASHI, Nagpur.

The paper draws attention to the essentially hydrophytic nature of this species. It has been found that the species tolerates a wide range of habitats but retains its anatomical feature indicative of adaptation to water environment, viz., the lacunar pith.

Further, the species has been shown to be a *hemicryptophyte* and not merely an annual as described usually in our floras. Experiments have proved that the hemicryptophyte is capable of sprouting throughout the year in presence of adequate quantity of water. The species is sensitive to soil drought rather than atmospheric dryness.

The paper describes some other significant features in the life-history of this species.

Lastly, it reports the existence of an *ecotype* which differs from the usual rainy season population of this species. This ecotype is a dry season form which shows characteristic differences in the growth season, floral features and anatomical characters. There is nothing in the structure or biology of this form that is even remotely suggestive of a life adapted to watery environment. Experimental cultivation of these forms has shown that the two are not interconvertible and that the distinctive features of each are hereditary.

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The dry season form has been found to grow only as an annual; the benefits of a hemicryptophytic habit being denied to it. This may explain the rare and sparse occurrence of this ecotype.

172. Genue *Hedychium* in Eastern India.

V. N. NAIK and G. PANIGRAHI, Shillong.

Genus *Hedychium* Koenig (1783) is represented in Eastern India by 23 species including *H. greenii* W. W. Smith (1911) from Bhutan and *H. wardii* Fischer from Delei valley, N.E.F.A.

It appears that compactness or looseness of the spike, shape and breadth of the bract, nature of the lip and redness or otherwise of the colour of the flowers, are more reliable taxonomic characters than the pubescent nature of the under surface of the leaves and the relative lengths of the stamen and the lip, the characters used by earlier workers in preparing key for various species of *Hedychium*. Accordingly, this paper re-evaluates the various morphological characters of taxonomic interest, suggests recognition of only 16 species in Eastern India within the limits of 19 species studied, proposes a key for easy recognition of these species and presennts an enumeration of the species together with field data on the habit and habitat of each species.

It seems that the edges of the tropical and subtropical evergreen forests provide "natural home" for the genue *Hedychium*, altough *H. aurantiacum* and *H. densiflorum* ascend higher to temperate altitudes in Nepal, Sikkim and N.E.F.A. *H. aureum, H. gratum, H. greenii, H. hookeri* and *H. marginatum* turn up as endemics to Eastern India.

Considering the great range of morphological intergrades together with discovery of various cytological types within *H. coronarium* complex and *H. elwesii*, the latter is treated here merely as another variety of the former species. *Again H. luteum* Herb. Calcut. is presumably based on a single specimen from Nonklow Swamp in Assam collected in 1852. This apparently holotype sheet has the stamen *as long as* but not *half as long again as* the lip and accordingly is identified as *H. coronarium* by Clarke. Hence *H. luteum* is considered merely as a biotype of the variable species *H. coronarium*. Finally, the morphological similarities between *H. griffithianum* Wall. from Khasi Hills and *H. venustum* Wight from Nilgheri and subsequent discovery of the latter species in Khasi Hills, suggest the merger of *H. griffithianum* Wall. (1853) in *H. venustum* Wight (1853).

173. Vegetation of Suhagi Ghats and Chachai Hills (Rewa Hills).

S. C. PANDEYA, J. S. SINGH, D. M. VERMA and B. S. AHUJA, Allahabad.

Rewa Hills are composed of Vindhyan sandstones. Due to weathering the periphery of the main plateau has been dissected into a series of low hills and valleys. Hills are conical and mostly not too sharp.

Climate of the area is hot with average total rainfall of 40 inches. Summers are very hot and dry and monsoon usually breaks in the 2nd week of June.

Rocks are well exposed in the area and the soil is thin, coarse and red "morrum". Due to oxidation of the 'upper surface the rocks look dark brown in colour. The slopes, in particular, and the total area, in general, are quite eroded. History of the area shows that it was previously covered with miscellaneous forests. Now due to intense felling, the vegetation has become very poor with low and sparse trees. Mention may be made here of the work of Richards (1960) who has accounted the absence of thick vegetation in such areas as being due to

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edapho-climatic conditions. Actually once the area is eroded and vegetation destroyed, the climatic conditions (more especially micro-climate) changes resulting in slowing down the upward plant succession. It is probably due to this phenomenon that the vegetation is poor in the area.

The vegetation is young, sparse and crooked. It is mostly scrubby with grasses filled in between the bushes. The dominant species are young plants of *Lagerstroemia parviflora* and *Anogeissus pendula*. The paper describes in detail the vegetation of Suhagi and Chachai Hills.

174. Phytosociology of Some Sal (*Shorea robusta* Gaertn. f.) forests of Mandla division (Mandhya Pradesh) on basic rocks.

S. C. PANDEYA, Allahabad.

Under certain climatic limits, distribution of Sal (*Shorea robusta* Gaertn. f.) forests has been generally correlated with underlying rock. Crystalline rocks have been assigned as the ones supporting Sal forests whereas basic rocks like besalt (Deccan trap) are shown to be devoid of it. Recently, however, Pandeya and Jain (1960) have observed the occurrence of Sal forests on basic rocks too. The present investigations were, therefore, undertaken to confirm and further the previous observations as also to compare the phytosociological characters of the Sal forests on basalt (deccan trap) and granite in the same locality and under similar conditions of climate.

Two localities of Mändla division were examined by phyto-sociological methods, viz., (1) Motinala (South Mandla Division)—Hills of basalt with small hillocks of granite and its exposures in valleys; Mangli—Hillocks of granite; Khursipar—Surrounding Hills of Basalt; (2) Dindori (North Mandla Division); Sarai—Complete basalt out-crop.

The Sal forests at Mangli (granite) and Khursipar (basalt) and those at Sarai (basalt) and Khursipar (basalt) have been compared statistically by (F×C) index community coefficient of the author (1961). The forests at Motinala are under mild grazing.

When the community composition of the Sal forests on basalt and granite at Motinala is compared the similarity works out to 89·7 where the forests on basalt at Motinala and that at Sarai (Border) have a similarity of only 72·7.

From these statistical comparisons it is concluded that :—

1. Under certain climatic limits *Shorea robusta* forests grow well on basic rocks like basalt.
2. Under similar conditions of climate and biotic influence the forests are largely similar even on different lithology like basalt and granite, in the present case.
3. Slight variation in any of the factors of climate or intensity of biotic operation changes the vegetation even on the same lithology.

175. Record of the Forest Plants around Bolangir.

H. PATTNAIK, Cuttack; P. C. TRIPATHY, Bolangir; M. MISRA, Cuttack.

Bolangir is an ex-state area of Orissa and is situated on its south-west part. It has an extreme climate and the area is ringed by chains of mountains. The plain has Black Cotton Soil. A record of the forest flora is described which contain about 109 species in 35 families. It is interesting to find the growth of Sal and Teak in this belt as it is the terminal part of Teak and Salt belts of central India. The species like *Feronia, Soymida, Zizyphus, Butea, Randia, Terminalia,*

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Gardenia, *Wendlandia* and *Nyctanthes* are the true ecotypes of the Black Cotton Soil. Besides the account of some of the most economic plants are also named among which *Diospyrus melonoxylon* (Kendu) occurs in the locality in profusion.

176. Contribution to the Flora of moist deciduous and evergreen forests in Shimoga District (Mysore State).

R. S. RAGHAVAN, Poona.

The paper deals with the types of vegetation met with in the evergreen semi-green and moist deciduous forests of Agumbe, Thirthahalli and Sacrebyle ranges of Shimoga District in Mysore State. The forests explored lie between 75° to 75°8'E and between 13°30' to 13°45'N and are situated at a distance of 10 to 90 kilometres from Shimoga proper. The altitude ranges from 300 m. to 800 m. and the rainfall varies from 200 cms. at Gajanoor to as high as 750 cms. at Agumbe, which because of its peculiar topography receives the maximum rainfall.

The dominant trees in the moist deciduous forests of Sacrebyle range are *Xylia xylocarpa, Dalbergia lanceolaria, Anogeissus latifolia, Salmalia malabarica, Kydia calycina, Schleichera oleosa, Adina cordifolia, Hymenodictyon exelsum, Pterocarpus marsupium, Meiogyne pannosa, Wrightia tinctoria* and species of *Terminalia*. As the elevation increases, the thick bamboo forests are replaced by palms and evergreen species as *Holigarna ferruginea, Gordonia obtusa, Alstonia scholaris, Glochidion* sp., *Knema attenuata, Diospyros* sp., *Hopea parviflora, Garcinia* sp. & *Grewia umbellifera* are seen in plenty. The evergreen forests at Agumbe are characterised by *Poeciloneuron indicum, Dipterocarpus indicus, Mesua ferres, Lagerstroemia lanceolata, Elaeocarpus tuberculatus, Dysoxylum malabaricum, Machilus macrantha* and *Aglaia roxburghiana*. Natural regeneration of the evergreen tree species is quite good inside the thick forests, and the forest floor is almost exclusively covered with genera of Zingiberaceae and Liliaceae, besides seedlings of *Murraya koenigii, Strobilanthes* sp. and *Clerodendrum infortunatum*. If the forests have not been disturbed too much, *Dillenia pentagyna, Knema attenuata, Elaeocarpus serratus, Lansium anamallayanum, Lophopetalum wightianum, Litsea wightiana* and *Actinodaphne* sp. are seen in plenty, perhaps forming a preclimax condition that may revert to the evergreen later on. In forests that have been cleared completely, the evergreen forests show a reversion to the deciduous type and only *Careya arborea, Randia brandisii, Methanthesa rhamnoides* etc. are seen. In barren rocks exposed to wind and constant leaching, *Phoenix humilis, Pteris* sp. and *Securinega* alone flourish.

Rourea prainiana, Vernonia ornata, Trichosanthes wallichiana, Adenosacme lawii, Sauropus androgynus, Laportea crenulata and *Commelina suffruticosa* are some of the new records reported from these forests.

177. Ecological studies of the vegetation of Gingee Reserve Forest, South Arcot District, Madras State.

K. RAMAMURTHY, Coimbatore.

Gingee Reserve Forest is situated in South Arcot District, Madras State at an altitude of ± 120 M. It comes under Tropical Dry Deciduous (Thorny) Forest. The area consists of hillocks and plateaus with seasonal streams, puddles and lakes. The mean annual rainfall is 107·26 cm. The temperature varies from 64·2°F to 101·8°F.

A systematic Ecological survey of the whole area have been made in different seasons and collected 308 species. A floristic list have been prepared in which

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species are arranged by strata, life-form and leaf-size classes with a distinction between the more and those less important. The synusial list of the floristic composition as shown by the number of species in each family is prepared.

The prepared Biological spectrum of Gingee R.F. shows that the Nanophanerophytes and Microphanerophytes form the dominant and co-dominant life-forms of the scrub communities; Therophytes and Geophytes form the dominant and co-dominant life forms of the ground floor communities.

The following communities were determined after analysing the mantle of vegetation by applying Quadrat Method.

Associations: Dichrostachys-Randia; Mimosa-Randia; Gymosporia-Randia; Dichrostachys-Gymnosporia; Dichrostachys-Mimosa; Dichrostachys-Barleria; Gymnosporia-Securinega; Gymnosporia-Carissa; Steblus-Cystacanthus.

Associes: Indigofera-Borreria; Indigofera-Evolvulus; Indigofera-Oldenlandia; Heteropogon-Heylandia; Ophioglossum-Cyperus; Xyris-Dopatrium; Isoetes-Hysanthus.

They were recorded in the vegetational map by giving special symbols.

178. The Vegetation around Jumnotri (Tehri-Garhwal).

M. A. RAU, Dehra Dun.

The distribution of vegetation in the altitude range 2 to 3300 metres and the vegetational composition of the main *Rhododendron campanulatum—Betula utilis* and *Abies—Betula—Quercus semecarpifolia* forests as observed by the author during a recent plant collection tour in the Jumnotri area of Tehri-Garhwal Himalayas are described. An interesting association of *Paeonia emodii—Aconitum lycoctonum* was met with at 2000 metres on the way to Jumnotri. The paper includes an enumeration of the angiospermous species collected during the tour and a note on their economic importance. The paper is supported by colour transparencies of characteristic vegetational zones and individual species of interest.

179. A contribution to the Vascular Flora of Vedharanyam and Talaignayar Reserve Forests.

K. M. SEBASTINE and J. L. ELLIS, Coimbatore.

The Vedharanyam and Talaignayar Reserve Forests, situated on the coast of Bay of Bengal, were botanically unexplored. Two botanical explorations were conducted during 1960-61.

The vegetation of Vedharanyam is a South Indian Dry Evergreen type showing gradual change from grassy and swampy types on the coast to a stunted dry evergreen type formed by trees with short boles and spreading crowns. Sea-shore vegetation is dominated by *Spinifex littoreus, Pandanus tectorius, Sopubia delphinifolia, Phyla rodiflora, Pedalium murex, Blumea obliquea, Salicornia brachiata, Suadeda monoica, S. nudiflora* and *Arthrocnemum indicum.*

The Dry Evergreen type forms the major portion and it is characterized by *Mimusops elengi, M. hexandra, Hemicyclia sepiaria, Walsura piscidia, Memycelon edule, Plecospermum spinosum, Hugonia mystax.* The ephemeral aquatic herbs seen are *Limnophila gratioloides, Ludwigia parviflora* and *Nesaea lanceolata.* The epiphytic species, *Viscum orientale, Dendrophthoe falcata, Cassytha filiformis* and *Vanda tessellata* occur. The mangrove species in the forest are *Aegiceras corniculatum, Avicennia alba* and *Excoecaria agallocha.*

Talaignayar Forest is formed by salt-marsh vegetation having extensive growth of species of *Suaeda, Rhizophora candelaria, Aegiceras corniculatum* and *Acanthus*

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ilicifolius. Fresh water aquatic plants like *Najas graminea, Ottelia alismoides* and *Aponogetor natans* are also seen.

210 species were collected and deposited in the Regional Herbarium, Coimbatore. Major families with number of species represented are as follows : Euphorbiaceae, 16; Rubiaceae, 11; Gramineae, 11; Cyperaceae, 11; and Acanthaceae, 10.

180. A Further Contribution to the Flora of Kannikatti Forest, Tirunelveli District.

K. M. SEBASTINE and T. L. SAROJA, Coimbatore.

The Kannikatti Reserve Forest, Madras State is bontanically an under-explored area. Three seasonal explorations were carried out during 1959-60.

The mountain slopes reaching on altitude of 830 m. show the scrub jungle, the dry deciduous and the moist evergreen types of forests. The scrub jungle characterised by *Acalypha alnifolia, A. indica, Caralluma attenuata, Gmelina asiatica, Hugonia mystax,* species of *Securinega,* and *Zizyphus* occurs below an altitude of 150 m.

Between 200 m. and 400 m. the vegetation presents species of *Biophytum, Cipadessa baccifera, Emblica officinalis, Gouania microcarpa, Hibiscus platanifolius, Homalium travancoricum* and *Terminalia catappa* forming the dry deciduous type.

Above 400 m. the moist evergreen vegetation presents gigantic trees with undergrowths of various habits such as *Anoechtochilus elatior, Goleus malabaricus, Dioscorea pentaphylla, Impatiens grandis, Sonerila tinnevelliensis* and Pteridophytes such as *Angiopteris evecta, Cheilanthes mysorensis, Cyclosorus parasiticus, Diplazium latifolium* and *Lastea aristata.*

Economically important plants, *Santalum album, Cymbopogon flexuosus, Hopea parviflora, Balanocarpus utilis, Tectona grandis, Coscinium fenestratum, Elettaria cardamomum* and *Ochlandra travancorica* are found in abundance.

521 species are collected from this region and deposited in the Regional Herbarium at Coimbatore. The enumeration consists only of those not previously reported for Kannikatti, of which three are endemic and ten exotic species.

181. Studies on the ecology and vegetation of the interior parts of Barmer and Jaisalmer Districts in Rajasthan.

SESHAGIRI RAO ROLLA and K. C. KANODIA, Poona.

The present paper gives interesting aspects of vegetation, studied along the interior parts of Western Rajasthan on Indian border covering the surroundings of Sinadari, Bundha, Khuyala, Kchhadi, Ludrawa villages with a rainfall below 15 cms. which were not worked out by earlier workers.

The area under study is divided into four distinct types :—

1. Low rocky hills and gravel mounds—in the surroundings of Barmer with *Commiphora-Grewia-Salvadora-Euphorbia-Zizyphus* association, of Jaisalmer with small communities of *Lepidagathis trinervis-Barleria scanthoides,* and of Ramgarh on way to Khuyala with *Bonamia latifolia* as the dominant comnent of the vegetation mixed with *Corchorus depressus, Dactyloctenieum aegytium* etc.
2. Sand dunes and sandy plains—around Sinadari and Sheo with *Prosopis-Capparis-Zizyphus-Calotropis* association on sandy plains, around Khuyala with *Panicum-Calligonum-Aerva-Leptadenia* association on typical sand dunes. Beyond Bundha the sand dunes are distinctly covered by the dominant species of *Tephrosia* mixed with *Aerva.* Around Kuchhadi *Dipterygium glaucum* is the most common species mixed with *Crotalaria, Fagonia, Aerva* and *Cenchrus* along the base of the barren and unsettled sand dunes.

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3. Saline plains which occupy a considerable area at Daiyyala ka Bundha on way to Ramgarh with *Aeluropus lagopoïdes, Cressa cretica, Sporobolus tremulus, Dichanthium annulatum* and between Baprasar-Ramgarh and Khuyala-Bundha with dominant growth of *Haloxylon salicornioum* mixed with stumps of *Panioum turgidum* and sparse growth of *Zizyphus* and *Capparis.*
4. Tank and River bed areas—around Sheo, Barmer, Sinadari and Amarsagar with interesting species of *Najas, Hydrilla, Marsilea, Scirpus* and others in the watery areas of Sheo tank, species of *Polygonum, Glinus, Heliotropium, Trianthema* in the dried up pond beds at Barmer and Amarsagar and species of *Arnebia, Alhagi, Fagonia, Bergia, Portulaca* and others along the dried river bed at Sinadari.

The details of the various plant communities in different types of habitat noted above are enumerated in the paper.

182. A contribution to the Flora of Gujarat.

SESHAGIRI RAO ROLLA and ANSARI M. Y., Poona.

Various aspects of the flora of Saurashtra region of Gujarat State have been discussed in the paper. A few interesting species such as *Fuirena uncinata* Kunth, *Cyperus pumilus* Linn., *C. difformis* Linn., *C. arenarius* Retz., *Fimbristylis spathacea* Roth., *F. tenera* R. & S., *Eleocharis atropurpures* Kunth, *Scirpus maritimus* Linn., *Commelina kurzii* Clke., *Cyanotis fasciculata* Schult. f., *C. cucullata* Kunth, *Sporobolus coromandelianus* Link., *Periploca aphylla* Done., *Mollugo nudicaulis* Lamb., and *Urginea wightiana* Hk. f., have been recorded for the first time in this region.

Notes on different types of vegetations namely—(1) Mangrove and sandy coastal vegetation, (2) Meadows and grasslands, (3) Dry scrub forest and (4) Deciduous forest, together with their chief components are also added to the paper.

183. Vegetation of Bharatpur (Rajathan).

SHANTI SARUP, Bharatpur.

Bharatpur connects the Gangetic plain to the Rajasthan. Studies in the vegetation of such an area are quite interesting from many points of view.

The vegetation of Bharatpur may be termed as luxuriant. The rainfall is sufficient. It is a low lying area and many marshy areas exist. Quite ideal places exist for the growth and development of water plants which have been treated separately.

There is, however salt in the soil and the flooding of the terrain in the rainy season to surcharge the soil with water for winter crops without irrigation, brings the salt to the upper layers. Some decades back salt extraction was flourishing industry of the area.

The main vegetation is xerophytic in character, common plants being *Prosopis specigora, Acacia Arabica* and other Acacias, a number of Asclepiadaceao, *Capparis aphylla,* specios of *Tamarix, Trifolium* etc.

Zizyphus is common and comes up as a persistant weed and left to itself it will form a scrub-climax in a few years. Grasses are common. The whole country side is dominated by *Athagi Marorum* just after the winter crops are reaped.

About 500 cpecies have been collected. A preliminary list of species collected is given. The paper will be illustrated by charts and photographs of the plant association of the area.

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Bharatpur is an interesting area for the study of the aquatic vegetation. Many hydresoral communities are represented in distinct zones. *Eichhornia crassipes* Solm, *Hydrilla verticillata* Casp, *Valisnaria spiralis*, Linn, and *Marsilia minuta* form pure associations. *Ipomoea-Limnathemum* association is formed by *Ipomoea aquatica* Forsk, *Ceratophyllum demursum* Linn, *Limnanthemum nymphoides* Linn, *Lemna miner* Linn, *Sagitaria sagitifolia* Linn, is common. About 60 water plants found in Bharatpur have been listed—P 410 Proc : 47th Ind. Sc. Cong. Part III Abstracts 1960 Bombay.

184. Humus Status of some Forest Communities of Bashahr Himalayas.

J. S. SINGH, Allahabad.

Humus is highly important from the standpoint of forest growth and production, controlling to a great extent the physical, chemical and biological properties of the soil. With a view to investigate quantitatively the humus status under different forest communities of Bashahr Himalayas, the studies reported and discussed in the present paper were made during the month of June, 1960.

The data shows that the ratio of total fresh litter/unincorporated humus and humus content of the surface soil is highest under *Quercus semecarpifolia* community. This may show the higher speed of litter decomposition under this community than the pure coniferous ones. As it is often observed that leaves decompose rather rapidly than twigs, etc., the ratio of leaf/twig amongst fresh litter assumes some importance in the decomposition. In the present studies this ratio does not give a clear indication in all the cases except in *Quercus semecarpifolia* community where it assumes the highest value. It may possibly be due to differences in the nature of decomposition of leaves of different species and floristic composition of communities. The presence of broad-leaved species like *Quercus semecarpifolia* and *Rhododendron arboreaum* and abundance of shRrubs like *Indigofera gerandiana* in conifer communities seem to favour the decomposition of coniferous litter as shown by the higher values of ratio of total fresh litter/unincorporated humus and soil humus under *Abies-Picea-Taxus-Quercus* and *Pinus wallichiana* (II) communities.

185. A preliminary study of topographical relationships in the vegetation of afforested Yumuna ravines in Agra.

S. SINHA and K. C. BASU CHAUDHARY, Agra.

Yumuna forms expensive ravines and vast areas of cultivated lands have thus been eroded. During the last ten years the ravines are being afforested and in Agra range *Acacia arabica* has been extensively planted. The undulating topography results in the formation of Ridge Flats, Slopes (Upper and Lower), Ravine Bottom, Submerged areas and Valley Flats and each of these bear characteristic vegetation in adaption to the habitat. Species occurring in each topography have been listed using line transect method and compared. The dominant vegetation is of xerophytic grasses and trees (*Acacia senegal, A. leucophloea, Prosopis juliflora, P. specigera, Salvadora oleoides, Zizyphus rugosa, Capparis decidua, C. sepiraria*). A total number of 83 species have been reported. Grasses dominate in the ground cover.

Almost all the herbaceous species grow in the wet season and there is little seasonal change in the vegetation. In winter hardly a few species grow and the rainy season flora persists in favourable places.

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186. Is it *Lagarosiphon* or *Nechamondra* ?

K. SUBRAMANYAM and N. P. BALAKRISHNAN, Calcutta.

In our Indian floras *Nechamandra alternifolia,* a common aquatic herb of Hydrocharitaceae, is described under the genus *Lagarosiphon.* Some authors use the name *Lagarosiphon roxburghii;* others place it under *Lagarosiphon alternifolia.*

Hutchinson separates *Nechamandra* from *Lagarosiphon;* in *Mechamandra* the stamens are always 2, without staminodes, and the leaves are alternate; in *Lagarosiphon,* the stamens are 3, sometimes with staminodes and the leaves are either alternate or verticillate. Geographically, *Lagarosiphon* is confined to Tropical and South Africa; *Nechamandra* occurs in E.S. Asia and N.E. Tropical Africa.

A careful study of fresh specimens from several localities in India has shown that the Indian specimens of this taxon have only 2 fertile stamens without any staminodes. The Indian plant is therefore *Nechamandra* and not *Lagaorsiphon.* Accordingly the correct name of this plant is *Nechamandra alternifolia* (Roxb.) Thw. This note presents complete synonymy, a detailed description, an illustration and a map showing distribution in India.

187. A preliminary account of the Flora of Sangam Area, Maharashtra State.

K. N. SUBRAMANIAN and SESHAGIRI RAO ROLLA, Poona.

A short account of a botanical tour taken to Sangam area along the Bank of Godavari river, Maharashtra State in November 1960, for botanical exploration by the authors is given in this paper. This area lies about 185 kilometres North-East of Poona along the Poona-Aurangabad Road in between 75°30′—76° E and 19°5′—20° N at an elevation of 800-950 metres. The soil in the river bed is clayey alluvium and in the plains it is gravelly mixed with sand. The rainfall is less than 80 cms.

The vegetation in this area can be mainly divided into *Grassland type* along the river banks and *scrub jungle type* in the plains.

The grassland is dominated by *Heteropogon contortus, Apluda varia, Andropogon pumilus, Aristida funiculata, Dinebra retroflex, Bothriochloa kuntzeana* and *Chloris tenella* mixed with herbaceous undergrowth of *Smithia sensitiva, Flaveria contrayerba, Commelina forskalasi* and *Bacopa monnieri.* Root parasites like *Striga densiflora* and *Sopubia delphinifolia* are very common in grasslands.

The scrub jungle is dominated by *Capparis decidua, Balanites roxburghii, Euphorbia tirucalli, Parkinsonia aculeata, Zizyphus maurantiana* and *Acacia arabica* associated with stragglers like *Caesalpinia bonduc* and Climbers like *Cryptostegia grandiflora, Cocculus hirsutus* and *Pentatrophis spiralis.* The common weeds in this dry locality are *Polygala chinensis, Alysicarpus rugosus, Lepidogathis cristata* and grasses like *Dicanthium annulatum* and *Melanocenchris jacquemontii.*

About 147 species belonging to 114 genera and 35 families of which Gramineae, Papilionaceae, Compositae, Amaranthaceae and Acanthaceae are dominant, are enumerated in the paper.

188. Occurrence of Rauwolfia canescens Linn. in Darbhanga District (Bihar).

MAHENDRA THAKUR, Patna.

Rauwolfia canescens Linn. has attracted much attention as a drug resource in our country. It has been found that this species is richer in active principles than *Raulfia serpentina* Benth. which has been well known hitherto for its medicinal value. The medicinal value of *Raulfia serpentina* Benth. lies in the fact that

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the tuberous roots are rich in alkaloids which are extensively used for various medicinal purposes. These alkaloids are found only in the roots of *Rauwolfia serpentina* Benth. whereas even the leaves are rich in these alkaloids in *Raulwolfia canescens* Linn. Therefore, this species commands much interest, indicating a more advantageous position than *Rauwolfia serpentina* Benth.

While studying the vegetation of Darbhanga District (Bihar), the author came across *Rauwolfia canescens* Linn. growing wild in large number on the sides of railway lines on the dilapidated Garhs of Rajas of ancient days and in the uncared mango orchards. Its occurrence is more common in northern parts of the districts than in the southern parts.

Hence, it is suggested in this note that the whole district of Darbhanga, particularly the northern area, may be best utilised for the extensive cultivation of this species so that commercial exploitation of alkaloids from the different parts of this plant may be possible. It may be mentioned here that there has been no report of this species from this district in any of the published records.

Cytology & Genetics

189. Study of the male gametophyte of higher plants by the use of fluorescence microscopy.

P. N. BHADURI and PRADYOT K. BHANJA, Calcutta.

The cytological constituents of the pollen grains and pollen tubes and the process of spermatogenesis in some higher plants were studied by means of fluorescence microscopy. The use of such fluorochromes as acridine orange, coriphosphine, auramine, berberine sulphate, acid fuchsin etc., under critically controlled hydrogen ion concentration and osmotic pressure, could clearly differentiate the vegetative, generative and sperm cells as well as other protoplasmic contents such as plastid-like bodies, lipid granules and mitochondria.

When using acridine orange, for example, viable pollen grains were either directlyy crushed in a 0·01% solution of the fluorochrome (pH 5·0 to 5·5) or they were previously germinated in sucrose solution with a trace of boric acid, inside moist incubating chambers. Observations and records were made using ultraviolet or blue-violet light with suitably coupled suppression filters. Where the walls of the pollen grains or pollen tubes interfered with the observation of the particular cell component in question, the latter was dissected or pressed out.

Both coloured and black and white photomicrographs were taken in support of the above observations and are presented in the paper.

190. Mutagenic action of Acridine Orange on *Neurospora cassa*.

K. L. CHAUDHURI, Calcutta.

In view of the high affinity of Acridine Orange dye to nucleic acids the genetic effect of the chemical was tested on the Neuspora system by employing the back mutation test. The technique followed consists essentially of plating spores of the Neurospora mutant S4894 in a high concentration on minimal medium. Colonies appearing on such a minimal medium are counted as reverse mutations.

Spores treated with concentrations of 50 μg per ml. and 100 μg per ml for 2, 4, 6 and 8 hours had considerable killing effect. At 6 hours 100 μg per litre treatment there was a drastic killing with the survival at 12·14% level. Some anomaly in the killing effect was observed and this appears to be due to irregular exposure to light during incubation. In another experiment using the concentration of 50 μg

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per ml. and varying the pH range from 4·8 to 8·8 treatments were given for 2, 4, 6 and 8 hours. A total of 114 reverse mutations were obtained. The maximum number of reverse mutations scored in a particular treated series was 18 as against only 2 in the control. The pH of the chemical solution does not seem to have any effect.

191. Preliminary report on the effect of X-irradiation on Ribonuclease treated cells.

DEEPESH N. DE and ARYA K. BAL, Calcutta.

In an attempt to explore the biochemical changes leading to X-ray damage, irradiation effects on Onion root tip cells were studied after pretreatment with ribonuclease. Three hours pretreatment of ribonuclease (1 mg/ml) preceeding X-ray irradiation (200r) was found to inhibit chromosome breakage, as has been visualised from the formation of micronuclei (0·3 micro-nuclei per hundred cells as compared to 29·5, in control where irradiation was not preceded by ribonuclease treatment and 0·0, where the cells were treated only with ribonuclease).

The radio-protective nature of ribonuclease has been attributed to its ability to impair intracellular deoxyribonuclease activity and the role of deoxyribonuclease in the chain reaction, that follows irradiation, has also been emphasised.

192. The "Sparse White" Mutant—A case of cytoplasmic inheritance in the variety *Karingkappal (N. tabacum)*.

D. M. GOPINATH, Rajahmundry.

In the tobacco variety *Karingkappal* (*N. tabacum*) a plant was noticed which was characterised by the presence of small white patches on the leaves. First it was thought to be a somatic mutation but studies revealed that this trait, like the albomaculatus, is transmitted by maternal inheritance. It was only when these mutant plants were used as the female parents that in the progeny the trait was found to have been transmitted but never in the opposite way. This "sparse white" mutant is characteristic in its own way and does not resemble the albomaculatus mutant. In the early seedling stages the character is not discernible but as development proceeds a small speck of white appears, usually starting from the margin of one or more leaves, and spreads to give "sparse white" patches on the leaves. These patches are confined only to the leaves and are never found either on the stem or on the floral parts. Selfed plants and crosses with the mutants as female parents against normal plants always show in the progeny 20-30 per cent. of mutant plants. Indications are that even though all the ovules that are borne on the female mutant plant carry the mutated plasmagene, the expression of the character in the offspring is governed by a complex bio-chemical reaction. The spread of the patches starting initially as a minute speck suggests that the bio-chemical product which disintegrates the chlorophyll and which is governed by the presence of the mutated plasmagene (and perhaps also by other extra nuclear constituents) is capable of permeating from cell to cell and wherever it permeates, it causes white patches on the leaves through disintegration of the chlorophyll.

193. Chromosome studies in Orchidaceae.

P. N. MEHRA and K. S. BAWA, Chandigarh.

This is a continuation work on the Cytology of Orchidaceae. Ninteen species belonging to eleven genera have been worked out from Simla and Narkanda area in the Western Himalayas. The details are as follow.

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Name of the plant	Chromosome number	
	n	2n
Cyperipedium cordigerum D. Don.	—	20
Orchis latifolia Linn.	20	—
Herminium monorchis R. Br.	—	40
H. angustifolium Benth.	20	40
Habenaria arietina Hook.	21	—
H. elisbethae Duthie	—	42
H. ensifolia Lindl.	21	—
H. edgworthi Hooker	21	42
H. intermedia Don.	21	—
H. pectinata Don.	21	—
H. susannae Don.	21	—
H. galeandra Benth	Ca 21	—
Hemipilia cordifolia Lindl.	—	44
Neottia listeroides Lindl.	—	40
Epipactis latifolia Swartz.	19	38
Cephalanthera ensifolia Rich.	—	34
Goodyera repens R. Br.	15	—
Liparis rostrata Reichb.	14	28
Calanthe tricarinata Lindl.	20	

(Species marked * are new reports)

Chromosome number in the genus *Hemipilia* is worked out for the first time. Secondary association of bivalents have been noticed in *Habenaria arietina, H. ensifolia, H. pectinata* and *Orchis latifolia* but their full cytogenetic significance is not yet known. *Habenaria* which is well represented in Western Himalayas have all the species uniformly with n=21. From previous report in two species of 2n=28 it can be inferred that the base number for the genus is 7 and all the *Western Himalayan* species are hexaploid. Himalayan race of *Orchis latifolia* is diploid but tetraploids are previously reported in literature. *Goodyra repens* and *Epipactis latifolia* occur as different cytotypes. The karyotype in *Epipactis latifolia, Neottia listeroides* and *Cephalanthera ensifolia* is asymmetrical. *Cyperipedium cordigerum* and *Calanthe tricarinata* have a symsetrical karyotype. According to nature of tetrad association the species are classified into three groups : (1) with tetrads associated in groups as in *Orchis latifolia, Herminium angustifolium* all the species of *Habenaria, Hemipilia cordifolia, Goodyera repens, Liparis rostrata* and *Calanthe tricarinata;* (2) tetrads free but members of a tetrad adherent and enclosed by a common wall as in *Epipacits latifolia* and *Neottia listeroides;* (3) members of tetrad free from each other as in *Cephalanthera ensifolia.*

194. Cytoplasmic inheritance in an "Albomaculatus" Mutant in the Cigar Tobacco variety *Vellavazhai*.

G. S. MURTY and D. M. GOPINATH, Rajahmundry.

An albomaculatus mutant was discovered in the cigar tobacco variety Vellavazhai. This mutant was characterised by the presence of white, yellow and green patches on the stem, leaf and the floral parts. Studies revealed that this character was cytoplasmic in inheritance. Mutant plants transmitted the albomaculatus character only when used as a female parent and never in the reverse way. It was further observed that the mutated cytoplasmic gene—the plasmagene—was not universally present in all the ovules that were produced by the maternal plant.

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Thus, the mutant plant when used as the female parent against a normal plant, not all the progeny were albomaculatus plants; the proportion of the abnormal plants varied from 2 to 20 per cent. Studies with a number of crosses with individual flowers having the expression of albomaculatus character in varied degrees (as evidenced by the extent of the patches on either the calyx or the wall of the ovary) showed that the ovules which arose from a mutated sector of the placental wall alone carried the plasmagene and consequently transmitted this trait to the offsprings. It was further observed that in a small percentage of plants showing the abnormality in the early seedling stages, the character was subsequently lost and the mutant seedling grew into a fully normal plant without transmitting the trait to its progeny—whatever way the crosses were made, with either a normal plant or another albomaculatus plant. The details of this cytoplasmic inheritance are discussed in the paper. Evidence from these studies indicates that the plasmagene causes the disintegration of the chlorophyll or prevents the formation of chlorophyll in the cells where it is present.

195. Studies on the cytology of two species of *Phymatodes*.

NIRANJAN PAL, Calcutta.

In *Phymatodes scolopendria* (Burm.) Ching and *P. nigrescens* (Bl.) J. Sm., the chromosome numbers are n=36 and 2n=72. The somatic chromosomes are characterised by the predominant occurrence of subterminal centromeres. The ratio of length of the shortest and longest chromosomes in both species is about 1 : 2·2. The length of the chromosomes ranges from 2·9—6·5 μ in *P. scolopendria* and 2·4—5·2 μ in *P. nigrescens*.

Meiosis is fairly regular in both species. In *P. nigrescens* the tetrad nuclei, in some of the sporangia, fuse together to form large tetraploid nuclei which immediately undergo 'secondary' meiotic division and show much irregularity in this division.

196. Cytological investigations of *Microsorum Punctatum* (L.) Copel. and *M. Musifolium* (Bl.) Ching.

NIRANJAN PAL, Calcutta.

The chromosome number in *Microsorum punctatum* (L.) Copel. and *M. musifolium* (Bl.) Ching are n=36 and 2n=72.

Meiosis is more or less regular. The somatic chromosomes have close range of variation in length (2·9—6·6 μ in *M. punctatum* and 2·9—6·0 μ in *M. musifolium*) and most chromosomes have subterminal centromeres. In *M. punctatum*, there is only one chromosome with nearly median centromere whereas the other species has two pairs with submedian centromeres.

197. Gametogenesis and the factors of sterility in *Russelia Equisetiformis* Schlecht and Cham. and *R. Coccinea* (Linn.) Wetist.

NIRANJAN PAL, Calcutta.

Russelia equisetiformis and *R. coccinea*, as they occur in India are found to be sterile. In a previous communication (Pal, Caryologia, *14* : 141-150, 1961) it has been shown that the meiotic cycle in the anthers of these two taxa is fairly normal. The present work was undertaken to ascertain the cause of sterility in these species.

The succession in the development of the floral organs is sepals, stamens and petals, and carpels. Microsporogenesis and development of the male gametophyte is normal. During development many of the anther tapetum cells become biseriate and a high number of microspores degenerates. The pollen grains are tricolporate

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and are shed at two-nucleate stage. The development of the female gametophyte follows the Polygonum type but its rate of growth is very slow and by the time the embryo-sac is matured, the corolla with stamens is already shed. Pollination and fertilization cannot take place as the style and stigma also wither away. So sterility in these plants is neither due to any abnormality in the development of the male and female gametophytes nor due to any cytological irregularity. The 'timing unbalance' in the development of the gynoecium seems to be responsible for the phenomenon.

198. Paramutation-like phenomenon affecting Aleurone colour associated with a Pericarp Character in Maize.

N. K. NOTANI and CHANDRA MOULI, Bombay.

A pericarp mutant in maize characterized by the development or red pigmentation around the silk-scar, has been repeatedly collected from the local Bombay markets. On crossing with homozygous coloured aleurone stocks it disclosed an unusual property of inhibiting the aleurone pigmentation : (1) when crossed as the male parent, the resulting kernels are considerably weaker in pigmentation, (2) when mated as the female parent the resultant kernels with a few exceptions are completely colourless. Back-cross to the F_1 with coloured aleurone stock as the recurrent male parent, yielded kernels giving a whole spectrum of aleurone pigmentation ranging from completely coloured to completely colourless. Three hypotheses were considered in explaining the foregoing data : (1) A single partially dominant inhibitor, which when present in two doses (as would be the case when coming through the female parent, the endosperm being a triploid tissue) completely inhibited the aleurone pigmentation and when present in single dose with double dose of aleurone colour factors, giving a partial suppression of the pigmentation, (2) Involvement of a cytoplasmic particle, (3) Occurrence of a paramutation-like phenomenon. From the analysis of the data, it seems that the last hypothesis is the more tenable one.

199. Cytotaxonomic studies in certain species of *Commelina* Linn. in Eastern India.

G. PANIGRAHI and R. V. KAMATHY, Shillong.

The paper presents an enumeration and distribution of nine of the 10 East Indian species collected from parts of Orissa, Bihar, Darjeeling, Assam and N.E.F.A. and records the haploid chromosome numbers of 5 species and a variety cytologically studied by us, as tabulated below :—

Name of species	Locality	n	Remarks
C. diffusa Burm. f. (=*C. nudiflora* of authors).	Digboi, Jorhat and Howrah.	15	
C. sikkimensis Clarke ...	Shillong.	45	Regular meiosis but 60% bad pollen grains, ovary falls off early; no seed setting.
C. benghalensis Linn. ...	Jorhat, Shillong	11	Occasionally 22 univalents at diakinesis, chromosome bridges at anaphase I.
C. paludosa Blume (=*C. obliqua* Buch-Ham).	Digboi, Shillong and Darjeeling.	30	
	Howrah	c. 55	
C. paludosa var. *viscida* Clarke (=*C. obliqua* var. *viscida* Cl.	Shillong, Cherrapunji.	30	Occasionally 2-4 univalents per cell or with 60 univalents at diakinesis.
C. suffruticosa Blume ...	Nongpoh	30	

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Thus, the genus *Commelina* appears to be characterised both by aneuploidy and inter- and intra-specific polyploidy based on x=11 and x=15. The finding of different cytological types is utilised to explain the existence of a large number of ecotypes in *C. paludosa* (=*C. obliqua*) complex, in tropical, subtropical and temperate altitudes.

Discovery of both interbivalent connections viz. 2(5)+2(2)+1(1) in *C. nudiflora* and 2(3)+1(2)+3(1) in *C. benghalensis* at diakinesis and inter-univalent connections viz. 2(5)+2(3)+2(2)+2(1); 1(10)+2(6); 1(8)+1(6)+1(1) and 1(9)+1(8)+1(2) together with chromosome bridges involving 1—3 bivalents in *C. benghalensis* at anaphase I, has been utilised to establish the unreliability of inferring basic chromosome numbers of a species or genus from the interbivalent connections or secondary associations at diakinesis or prometaphase (cf. x=4 in *C. benghalensis* Sharma, 1955).

200. The Cytology and inheritance of B chromosomes in Pennisetum typhoides.

J. V. PANTULU, Vizianagram.

The B chromosomes in Pennisetum typhoides differ from the A chromosomes in their smaller size, they are half the size of the shortest A chromosome of the complement. There is variation in the number of B's in the cells of the same root tip. A similar variation in number of B's exists in the pollen mother cells of the same flower and in the same anther also.

At pachytene the B chromosomes show the following structure. The centromere is sub-terminal and on either side of the centromere are heterochromatic blocks. The short arm consists entirely of heterochromatin and in the long arm following the heterochromatic region there is light staining "euchromatic" region with eight chromomeres distributed along its whole length. The B chromosomes do not pair with the A chromosomes. The B's regularly pair among themselves and form trivalents and quadrivalents when present as higher numbers. Non-disjunction at anaphase I in the pollen mother cells was observed in plants with 2, 3 and 4 B chromosomes. Precocious division of B chromosomes was noted at anaphase I. Non-disjunctionn at anaphase I contributes to progeny with smaller and larger number of B's than expected from the number present in the parents. Precocious division of B's at anaphase I, followed by a division at anaphase II results in progeny plants with higher number of B's than expected.

In the progeny of a cross between plants with 0-B and 2B's in addition to the expected I B plants, plants with 2 & 3 B's also appeared. In the progeny of crosses between plants with 2 B's plants with 1 B, 2 B's and 3 B's were realised in addition to the expected 2 B plants.

201. Cytological observations on some grasses from Allahabad and Kotwa in Uttar Pradesh.

R. P. PATIL and KRISHNA GHOSH, Allahabad.

Alloteropsis cimicina Stapf: 18 bivalents occur at diakinesis. There appears to be no previous report. If 9 is the basic number in genus *Alloteropsis*, *A. cimicina* is a tetraploid.

Eragrostiella brachyphylla Bor: n=18 in PMC squashes. There appears to be no previous report. Sometimes there is a chain quadrivalent at diakinesis. This count indicates the basic number of a 9 in *Eragrostis* sect. *Plagiostachya* (=*Eragrostiella* Bor) in addition to 10.

Brachiaria ramosa Stapf: Metaphase I and diakinesis show 16 bivalents and there is a 16—16 separation at anaphase I. This number does not agree with

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the previous report by Mulay and Leelamma. Present observations suggest basic number of 8 in addition to 7 and 9 previously proposed for the genus *Brachiaria*.

Paspalidium flavidum A. Camus : At metaphase I there are 9 bivalents. The previous report was n=27 (Raman *et al.*). Thus diploid and polyploid races occur in this species.

Iseilema laxum Hack. : 14 bivalents appear at metaphase I. This agrees with the previous report by Joshi *et al.* At least three chromosome races occur in this species with the basic number of 4.

PMC material for the species of *Alloteropsis, Eragrostiella* and *Iseilema* was collected at Kotwa forest plantation, 11 miles south of Mirzapur, and for the other species at Allahabad.

202. Induced changes of husk colour in *Oryza sativa* Linn by radioactive phosphorus.

BALARAM MAJUMDER, Calcutta.

For the induction of mutation in *Oryza sativa* Linn., an autumn paddy, variety Marichbati, was irradiated with Beta rays from radioactive phosphorus (P^{32}). The isotope was used in the form of phosphate ions ($Na_2 HPO_4$) and the initial activities was 15 μc/seed for 24 hours.

In the P_1 generation one aberrant plant S. 1 was isolated that had seven tillers, and the colour of the husk was black in four tillers out of seven and the three remaining tillers had the normal yellow colour of the husk.

In the seedling stage of the P_2 generation, out of 272 seedlings, 200 showed black tillers, a changed colour, and remaining 72 seedlings had green tillers which resembled the parental tiller colour.

Plants with black tillers, on maturity segregated into four types of plants with different combination of husk colours and awn characters. They were as follows, husk colour black and awnless, husk colour black with awn; husk colour yellow with awn; and husk colour yellow without awn (Parental character).

But the seedlings that showed greenish white tiller, on maturity had the parental yellow colour of the husk and behaved as normal.

Further studies on the isolated types are on progress.

203. Induced Vegetative Abnormalities in *Oryza sativa* Linn by Ionising X-rays.

BALARAM MAJUMDER, Calcutta.

One X-ray induced abnormal plant (S. 275) was isolated in the X_2 generation of Marichbati variety, an autumn paddy following exposure of the dry seeds to 75,000 r X-rays. The seeds of the selection S. 275 were maintained up to X_4 generation for multiplication and further observation.

The population raised in the X_4 generation from the selection S. 275 were very strong in vegetative structure against the control plants. Mean height and leaf breadth of the population from S. 275 were lower and narrower respectively than the control population.

Various types of leaf abnormality were noticed in the plants of S. 275. The types of abnormality are as follows. Simple leaf blade, forked leaf blade, union of two equal leaf blades etc.

In all the types of leaf blade there are two mid vein running either parallel side by side close to each other as in the simple leaf, or they run through the mid region of the two different individual leaf blades.

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Leaf apex in the population of S. 275 is one as in the simple leaf blade type or two, as in the forked type and fused leaf blade type of equal or un-equal sizes.

Smooth leaf base is absent in the plants of S. 275 as against the presence of smooth leaf base of the control. Also a groove with two ridges containing two parallel veins is present in each leaf bases of the population raised from S. 275 selections.

204. Inheritance studies on a colour mutation in jute.

RABINDRA KRISHNA BASU, Calcutta.

One of the most interesting genetic change induced by ionizing radiations in jute was change of colour of entire plants, when the seeds of three varieties of *Corchorus olitorius* L. viz. *Tall Mutant, Chinsura Green and R. 26* were irradiated with P^{32} beta rays. *Tall Mutant* is a X-ray mutation isolated in the Botany Department, Bose Institute, in the year 1947. In the P_1 generation grown particularly from the variety *R. 26,* a few seedlings developed into plants simulating the colourations of *Tall Mutant* and *Chinsura Green;* the rest appeared as *R. 26.* The plants, which appeared as *Tall Mutant,* when crossed with *R. 26* or when selfed and grown in P_2 generation, segregated into the mutant and the mother line characteristics in the usual monohybrid ratio; while those appeared as *Chinsura Green* bred true in later generations. This new mutation isolated from the P_1 generation in the dominant, heterozygous form has been named as *Tall Mutant II.*

The evidences so far obtained from the F_2 and back cross generations of crosses involving *Tall Mutants, R. 26 and Chinsura Green,* indicate a single factor difference among them and the inheritance of pigmentation in these varieties is controlled by a multiple allelomorphic series.

Tall Mutant II has also been found to be an early flowering type compared to the *Tall Mutant,* but both the mutations are late flowering compared to the mother line *R. 26.* Like many other early flowering types isolated by the present investigator, *Tall Mutant II* has a very long flowering period.

205. On the influence of colchicine on the mitotic behaviour of *Urginea Inicad* Kunth., the Indian squill.

K. RANGASWAMI AYYANGAR, Annamalainagar.

The present work was undertaken with a view to investigate how far the mitotic behaviour of the cell nuclei in *Urginea indica* Kunth., the Indian Squill, reacts to the influence of the plant alkaloid, Colchicine. For this purpose, bulbs of this plant were grown in pots filled with sandy loam and also in glass bottles containing tap water. The root tips which emerged from the bulbs were made to dip in various concentrations of Colchicine in water ranging from 1%—0·00125% for varying periods of time (1 hour to 72 hours).

Broadly speaking, the effects of the chemical on the mitosis can be classified into two categories, namely, lethal and non-lethal. Under the first category, come those cases of cell nuclei which, under the potent influence of the alkaloid (1%, 0·5% and 0·25% for 4 hours, 8 hours and 12 hours respectively) undergo serious narcosis leading eventually to necrosis or death. The nuclei and the chromosomes in such cases look like so many amorphous pycnotic mashes. Under the second catefory with lesser concentrations (0·125%—0·0125%), come those coses of cells in which the chromosomes either exhibit corrosions leading to transverse fragmentation, the numerous chromosomal fragments so formed beings pread out

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all over the cytoplasm and reminiscent of irradiation effects; or undergo duplication through longitudinal splitting and arrest of anaphasic separation due to the impairment of spindle mechanism. It is already known that one of the causes of evolution of newer life forms is polyploidy resulting in altered hereditary outfit with which the new organisms are able to stabilise themselves in relation to the environment. The karyological changes recorded here would appear to afford a clue as to how this mechanism of organic evolution works in nature.

206. Cytological studies in some *Solanum* species.

B. G. S. RAO, Waltair.

The cytology of *Selanum trilobatum* and *S. torvum* has been studied especially with reference to the morphology of chromosomes at pachytene.

In both species (2n=24) the pachytene chromosomes share certain common features such as (i) they are highly differentiated and the heterochromatic regions are present in either side of the conspicuous centromere while the distal parts consist of euchromatic regions, (ii) the total length ranges from a maximum of 45 microns to a minimum of 25 microns and (iii) the single nucleolus organising bivalent present in each species is more or less subterminal with a terminal satellite in its short arm. However, it occupies the 10th position in *S. torvum* whereas in *S. trilobatum* it is the shortest of the complement being the 12th chromosome in the order of length.

On the basis of morphological data gathered, the 12 pachytene bivalents have been identified, described and a key to their identification presented. Besides total length and position of centromere (arm ratio), the characteristic disposition of the heterochromatic regions serve as diagnostic features in identification of individual chromosomes.

Meiosis is regular and normal.

Preliminary studies made in *S. indicum, S. xanthocarpum* and *S. melongena* reveal that in these also the pachytene chromosomes are differentiated and the chromosome complement in each species (2n=24) includes a single sub-terminal nucleolus organising bivalent with the satellite terminating the short arm.

207. Cyto-taxonomical studies of the Fern-flora of Parasnath Hill.

R. P. ROY and S. N. PANDEY, Patna.

Cyto-taxonomical studies of the fern-flora of Parasnath hills have not been done before although this place is very rich in fern vegetation. With a view to have a detailed knowledge of the different genera occurring there a systematic cyto-taxonomical work on the subject has been undertaken in this laboratory.

A preliminary account of the meiotic and mitotic studies in a few species done so far is given here :

Pteris cretica Sw. has been found to be apogamous with 2x=58. This species produces only 32 well developed spores which come out of an eight celled sporangium. *Pteris longfolia* L. has been observed to be a tetraploid with x=58 and 2x=116. It is a normal sexually reproducing plant where 64 spores are produced. The third species *Pteris quadriaurita* Retz. is a sexual diploid species showing 29 bivalents in SMC and 58 chromosomes in the somatic tissue.

Tectaria irregularis (*Presl.*) *Copel.* (*Dictyopteris irreguaris Presl.*) has also been cytologically investigated. It shows 40 bivalents and is a sexual diploid species.

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Polyplodium longissimum Bl. (*Pleopeltis longissimum Moore*) showed 74 chromosomes in its root tip squash and is perhaps a diploid species.

Detailed investigations which are in progress will be published in due course.

TABLE

Sl. No.	Species	x	2x	Remarks
1.	Pteris quadriaurita ...	29	58	Diploid.
2.	Pteris cretica	58	"58"	Diploid (apogam.)
3.	Pteris longifolia	58	116	Tetrapoid.
4.	Tectaria irregularis ...	40	—	Diploid.
5.	Polypodium longissimum ...	—	74	Diploid.

208. Endosperm cytology of *Hopea odorata* and an *Oenothera* species (an introduced cultivated form).

R. P. ROY and R. P. JHA, Patna.

The present report is a continuation of the authors' previous notes on endosperm cytology of other species (Roy and Jha, 1959, 1960). Both these species had nuclear endosperm. Six weeks old endosperm of *Hopea odorata, Roxb.* showed nuclei with 21, 28, 35, 42, 49, 56, 70, 84 and 112 numbers of chromosomes at metaphase. Majority of the nuclei had, however, 21 chromosomes, the triploid number, and a few one with higher numbers. 8 weeks old endosperm of *Oenothera* species had nuclei with 14, 28, 49, 56 and 70 numbers of chromosomes at metaphase. Again in this species also, most of the nuclei had 14 chromosomes i.e., the diploid number, and only a few nuclei had higher numbers. Thus the endosperm which, to begin with, was triploid in *Hopea odorata, Roxb.* and diploid in *Oenothera* sp. became myxoploid as it developed.

In some nuclei at anaphase, in *Oenothera* sp., laggards were seen. Besides this in both the species, endosperm nuclei of greatly variable shapes and sizes with variable numbers of nucleoli were noted. Normal nuclei, polyploid nuclei, dumbel-shaped nuclei and micronuclei, all were found. At early stage of cell wall organisation in *Hopea odorata, Roxb.* variable numbers of nuclei were enclosed in a cell. In some cells there was only one nucleus, in others 2 or 3 or even 4. This may have given rise to polyploidy by fusion of 2 or more endosperm nuclei in a cell. Detailed studies have also been made and will be published elsewhere.

209. Colchicine treated Opuntia.

R. P. ROY and N. C. MISHRA, Patna.

With a view to induce polyploidy in *Opuntia monacantha,* growing phylloclades were treated with varying concentration of colchicine for different hours.

Effective dose was 0·04—0·05% colchicine supplied for about 18 hours resulting in spineless phylloclades, which were otherwise spiny.

When a few of this spineless phylloclades were separately potted, new phylloclades coming from them were also spineless,

Cytological investigations of this new types of phylloclades is in progress.

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210. Cytogenetic investigations in Cucurbitaceae.

R. P. ROY and A. R. MISHRA, Patna.

Cytological studies of the following cucurbits, both cultivated and wild, with regard to their chromosome number and meiotic and breeding behaviour have been made :

1. *Bryonopsis laciniosa*, L. ... ... 2n=24
2. *Cephalandra indica*, Naud. ... ... 2n=22+xy
3. *Cucumis melo*, L. ... ... 2n=24
4. *Cucumis sativus*, L. ... ... 2n=14
5. *Trichosanthes cucumerina*, L. ... ... 2n=22

Meiotic studies at metaphase I showed large P.M.C.s with regular small bivalents. The chiasma frequency was low. Anaphase was normal and so was the tetrad formation. Preparations in carmine gave much better results than those in feulgen. In *Cephalandra* one bivalent was found to be heteromorphic. Seconnary association among bivalents was well marked. *Cucumis melo*, sometimes, showed non-synchronised disjunction at anaphase one.

Some crosses have been successfully made and the genetical work is in progress.

211. Cytological studies in Malpighiaceae.

R. P. ROY and N. C. MISHRA, Patna.

Cytological investigations i.e. chromosome number and miotic behaviour of the following cultivated members of the *Malpighiaceae* have been made.

Galphimia gracilis
Hiptage Madablota
Stigmophyllon littorales

Somatic studies were made from propionocarmine squash preparations of the root tips after proper pretreatment with 8-hydroxyquinolene. Miosis was studied from squash preparations of anthers.

Somatic counts from the following members :

G. gracilis ... ... 2n=24
H. madablota ... ... 2n=42-56
S. littorales ... ... 2n=22

Meiotic behaviour was irregular in *G. gracilis* and *H. madablota*. In *G. gracilis* 12, 18 and 24 bivalents were seen to be formed.

In *H. madablota*, the number of bivalents varied in different P.M.C.'s and number of univalents and one quadri-valent were regularly seen in each P.M.C. The total number of chromosomes in different P.M.C.'s differed from 42 to 56.

In *S. littorales* 11 bivalents were regularly formed and the subsequent stages were regular.

212. On a Polyploid *Achyranthes bidentata*, Bl. (2n=84) in Nature.

R. P. ROY and V. THAKUR, Patna.

Earlier the chromosome number of *Achyranthes bidentata*, Bl. has been reported as 2n=42 (Sugiura, 1936) and n=21 (Roy and Thakur, 1961). Now, in the present paper is recorded an existence of another cytological race with chromosome number 2n=84. If the basic number as suggested be 7 for the genus, the chromosome number naturally speaks for a high degree of polyploidy (12-ploidy) prevalent in this species bringing the genus on par with *Amaranthus, Celosia, Gomphrena* and others of the family Amaranthaceae where polyploidy seems to have played an important role in making them effective weeds.

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The 84-chromosomed population of *A. bidentata* flourishes in nature with only negligible cytological abnormalities, bearing no effects on pollen-viability and the percentage of seed-set. Multivalents up to 0·5%—1%—both trivalents and tetravalents —are observed during metaphase I of the dividing pollen mother cells but equal distribution of chromosomes to the two poles is ensured in anaphase I. The regular meiotic division suggests a fairly early origin of this polyploid race.

Morphologically, this race is distinguished from the normal diploid one in its lax spikes and smaller, less pointed, obovate leaves with silvery undersurface when mature.

213. Cytological studies in Myrtaceae.

R. P. ROY and R. P. JHA, Patna.

Cytological studies in some myrtaceous species have been made and their account is given below. The following chromosome numbers have been determined for the first time :

Name of the species.	Somatic number (2n)	Gametic number (n)
1. Myrtus communis, Linn. ...		11
2. Psidium guayava, Linn. var. typica.		11
3. Psidium guayava, Linn. var. 'Chinese guava'.	22	
4. Eugenia jambolana, Lamk. (cultivated var.)	55 (Tjio, 1948=44, Bhaduri and Ahmad, 1949=66).	22 (Bhaduri and Ahmad, 1949=33).
5. Eugenia jambolana, Lamk. (wild variety)	33	
6. Eugenia jambos, Linn. ...	33, 44 (Bhaduri and Islam, 1949=46).	22 (Piji, 1934=21, 27). (Bhaduri and Islam, 1949=23).
7. Eugenia javanica, Lamk. ...	33 (Bhaduri and Islam, 1949=45).	22, 33, 44, 55.

In *Psidium guayava,* Linn. var. *'Chinese Guava',* (a variety with very small leaves), somatic number was found to be 22; and in cultivated variety of *Eugenia jambolana,* Lamk. it was 55 and in wild variety 33. *Eugenia jambos. Linn.* showed 2n number=33 and 44 and *Eugenia javanica, Lamk.* 2n=33.

Meiosis in *Myrtus communis, Linn.* and *Psidium guayava, Linn.* var. *typica* was normal forming regular 11 bivalents with no meiotic irregularities at any stage. In cultivated variety of *Eugenia jambolana, Lamk.* the same anther showed 22 and 33 bivalents and the pairing was normal. But in the wild variety univalents, bivalents and multivalents were seen. In *Eugenia jambos, Linn.* meiosis was quite normal and 22 bivalents were always found. In *Eugenia javanica. Lamk.* again meiosis was very irregular and pairing was never normal. At metaphase I a number of univalents and multivalents along with bivalents were distinctly seen. The total number of chromosomes at metaphase I was found to be 22, 33, 44 or 55. Detailed studies have been made and are going to be published elsewhere.

214. The *Amaranthus gangeticus* –Complex.

R. P. ROY and V. THAKUR, Patna.

The present investigation consists of a comparative study of various characters of the external morphology of different populations of *Amaranthus gangeticus,* Linn.

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and, in addition, a preliminary cytological analysis of some sterile and partially sterile plants found in nature.

The characters studied were : (i) leaf-shape, (ii) lamina/petiole ratio, (iii) laminar width/length ratio, (iv) spike form and (v) the pollen sterility and seed-set.

In the reduction division of the pollen mother cells of sterile and partially sterile plants, numerous cytological irregularities, such as presence of univalents, laggards, pentads, etc., were observed.

The characters were all highly variable and so overlapping that no distinct lines of demarcation could separate the specimens adequately. Though taxonomically treated as a single species *A. gangeticus* comprises a wide range of forms, which at one extreme approach *A. viridis*, L. and at the other, *A. polygamus*, L. *A. blitum*, L., *A. oleraceus*, L., *A. tricolor*, L. and *A. Caturus*, Heyne. etc. Unfortunately enough the systematic position of many of the above species is open to controversy.

It appears that *A. gangeticus* has arisen through hybridisation between these very different amaranths and no wonder, sometimes, involving more than two at a time.

215. Cytology of Cyperaceae.

B. R. SHARMA, Chandigarh.

Cytology of the following 12 species of Cyperaceae has been worked out from Chandigarh and Simla area. Previous counts of chromosomes are enclosed within brackets.

No.	Species	Chromosome number		Previous author and year	Place
		n.	2n		
1.	*Pycreus globosus* Reicht (syn. *P. capillaris* Nees)	40	—	—	Chandigarh Simla
2.	*P. pumillus* Linn. (syn. *P. nitens* Nees)	47	—	—	
3.	*P. sanguinolentus* Nees (*Cyperus sanguinolentus* Vahl)	25 (24)	— —	— Tanaka (1941)	Simla
4.	*Mariscus paniceus* Vahl ...	42	—	—	Simla
5.	*Juncellus laevigatus* Linn. ...	43	—	—	Chandigarh
6.	*Kyllinga squamulata* Vahl ...	54	—	—	Simla
7.	*K. cylinderica*	56	—	—	Simla
8.	*Fimbristylis dichotoma* (Linn.) Vahl	5 —	10 (10)	— Sharma & Bal (1956b)	Chandigarh
9.	*F. complanata* Link var *kransiana* Hassk	5 (8)	— —	— Tanaka (1939d)	Simla
10.	*Bulbostylis capillaris* Kunth ...	36 —	— (84)	— Tanaka (1937)	Simla
11.	*Scirpus supinus* Linn. ...	14 —	28 (28)	— Sharma & Bal (1956b)	Chandigarh
12.	*S. maritimus* Linn. ...	48, 55 — — — —	— (ca 104) (80) (86) (110)	— Hakansson (1928) Rodrigues (1953) Blackburn (1936) Tanaka (1937)	Chandigarh

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Chromosome numbers of 6 species (Nos. 1, 2, 4, 5, 6 and 7) are worked out for the first time. In case of 3 species (Nos. 3, 9 and 10) the present observations are at variance with the reports of previous authors whereas in 2 species (Nos. 8 and 11) these are in conformity with them. *Scirpus maritimus* (No. 12) appears to be a species complex; two haploid numbers are recorded here, i.e. 48 and 55, the former being different from the previous reports whereas the latter agrees with one of them.

Chromosome numbers in the species examined here range from 5 to 56 and form an aneuploid series. Morphological study of these species is being done to find out any possible correlation in the chromosome numbers and their taxonomy.

216. Chromosomal differentiation between *Oryza perennis* and *Oryza sativa*.

S. V. S. SHASTRY and R. N. MISRA, New Delhi.

The study of meiosis in the F_1 hybrid, *Oryza sativa* (4n) × *O. perennis* (2n) revealed that in every PMC, 1-12 trivalents occur. While the earlier studies indicate that the chain shaped trivalents are most frequent in antotriploids, the present study of intra-genomic hybrid indicate that the frying-pan shapes are the most frequent, ranging from 1-10 per PMC. This observation was interpreted to mean that the chromosomes of *O. perennis* are segmentally homologous to those of *O. sativa*. The shapes of quadrivalents and hexavalents were confirmatory to the above interpretation. Further, some trivalents were ring shaped while some pentavalents were dumpbell shaped (○ – ○), which indicate the secondary and tertiary trisomic condition of the hybrid for some chromosomal segments. This observation indicates that fairly large translocations involving the chromosomes differentiate the keryotype of the two species, *O. sativa* and *O. perennis*.

217. Karyotypic studies in *Oryza* by pachytene analysis.

S. V. S. SHASTRY, D. C. DAS and K. GOPAKUMAR, New Delhi.

The karyotypes of 4 forms of *Oryza spontanea* and 3 forms *Oryza perennis* Moench. (*O. perennis* var. *barthii*, *O. perennis* var. *balunga* and a collection from Assam) were studied by pachytene analysis. The bivalents of *O. perennis* are thicker and are uniformly stained with no chromomeric details while those of *O. spontanea* are thinner, and are seriated by macro- and micro-chromomeres along with small darkly stained segments. The karyotypes of two forms of *O. perennis* (var. *barthii* and a collection from Assam) are classified under the group 1 b of Stemmins (1958) while that of the var. *balunga* is classified under the group 2 b. All the four forms of *O. spontanea* are included under the group 2 b. It would be observed that the karyotype of *O. perennis* is more symmetric than that of *O. spontanea*. Further, while the pairing at pachytene was normal in *O. perennis*, various abnormalities like differential segments, loosely paired regions, heteromorphic terminal ends were observed in *O. spontanea*. These abnormalities in *O. spontanea* can be either due to the hybrid origin of this complex group, or due to its out-pollinated nature. Some loosely paired segments were observed at pachytene on *O. perennis* var. *barthii*. The significance of these observations for the interrelationship of these species is discussed.

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218. Meiotic studies in some Malvaceous species.

R. P. SINHA, Patna.

The present paper deals with the meiotic studies in three species of two genera of Malvaceous plants. A brief account of the results has been tabulated below—

Name of Plants	Previous reports	Authors	Present finding
1. *Sida acuta*, Burm.	2x/14, 28	Skovsted 1935	28
	18	Roy & Sinha 1961	
2. *S. rhombifolia*, L.	14	Skovsted 1941	14
3. *S. alba*, L.	—	——	14
4. *Hibiscus abolmoschus*, L. ...	72	Skovsted 1935	72

Two different populations in *Sida acuta* have shown two different sets of bivalents. One has shown 9 while the other has shown 14 bivalents suggesting that six and seven may both be regarded as the base numbers in the species in the same way as in *Callirhoe* sps. (Skovsted, 1935). This species might possibly have arisen from two different ancestors. They may be regarded as genetic races of the same species. Karyotype analysis and pollination frequency is under investigation and is expected to yield interesting results. The prostrate variety of *Sida rhombifolia* shows 7 bivalents at MI and their configuration is quite different from previous reports. Transplant experiments have been performed with prostrate and erect varieties and it has been concluded that they are not ecotypes but distinct varieties of the same species. The meiotic studies of the other variety is in progress and it is hoped that phenotypic variation may be related to genotypic distinctness.

Interesting results have been found in *Sida alba*. Morphological concept of the species *Sida spinosa* appears to be in a state of confusion. Some taxonomists regard that this has two varieties—one yellow flowered and the other white flowered. Others like Roxburgh separate them into two distinct species, the former type as *Sida alnifolia* and the later as *Sida alba*. In the expectation that meiotic behaviour of the types may give some clue to the delimitation of species, the present studies in the context was undertaken. *Sida alba* shows 7 normal bivalents which differ from those of *Sida spinosa*. Comparative studies with *S. alnifolia* may further clarify the point.

Seventy two bivalents were seen at MI in *Hibiscus abolmoschus* and the number coincides with the commonly cultivated species *Abolmoschus esculentus*. It was hoped that the comparative studies of the two might throw some light on their interspecific relationship. Another important feature was the bivalents at different stages of separation in the same plate. This appears to be significant. This may perhaps lead to meiotic irregularities. Further investigation in this direction is being pursued.

219. "Reversed Geam" and Female Sterility of *Zea mays* due to the 'Ameiotic' Gene.

S. K. SINHA, Cuttack.

The recessive allele of the 'ameiotic' gene in maize reported by Rhoades and Sinha causes complete male sterility and almost complete female sterility. Occasionally, a few triploid kernels may be found in ameiotic ears. The number of such kernels is variable in different families and may range from 0 to 20 or more. Certain observations suggest the possibility that factors for the "reversed germ"

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condition may modify the action of the ameiotic gene so as to reduce the degree of female sterility to some extent. The "reversed germ" as found in some varieties of maize like the "Country Gentleman" sweet corn is expressed in two distinctly different ways : (1) The germinal face is oriented towards the base of the ear instead of towards the tip, which is usual. (2) Both the lower and the upper spikelets develop in the ear instead of the usual condition of the development of the upper spikelet only. Considering several types of observation it is postulated that reproductive structures farther removed from the usual site(s) or locus of reproductive development tend to be relatively less affected by the drastic action of the ameiotic gene. Genetic experiments to test this postulation have been planned and are in progress.

220. Histological studies of the X ray induced mutants of Jute. III. Non-shattering pods in *Corchorus Olitorius* L.

SUBIR SEN and S. PAUL, Barrackpore.

Generally there is a 20 to 25% loss of seeds in *Corchorus olitorius* due to shattering of pods, while harvesting for seeds. A non-shattering pod type has been isolated from X-ray irradiated progeny of 70,000r treatment in the X_3 generation of JRO 632. The fruit-wall is characterised by the presence of a fibre bundle capping each dorsal vascular trace and of narrow discontinuous mucilage cannals in the mesocarp at the ridges of the dorsal suture. In the normal non-irradiated plants with shattering pods, however, there is no fibre bundle capping the dorsal vascular trace and the mucilage cannals are large and well developed, running all along the length of the fruit and acting as hinges on absorption of moisture to bring about a loculicidal dehiscence. The fibre strands capping the dorsal vascular strands in the variant possibly counteract the stress of loculicidal dehiscence.

The seven very late flowering morphological variants in the same progeny, are found with small stumpy pods. The fibre bundles capping the dorsal vascular trace of the fruit wall is comparatively large and is continuous laterally with the endocarp which has been transformed into a single layer of stone cells (sclerieds). These fruits resist shattering even on mechanical handling.

221. Cytology of endosperm of *Vicia faba* L.

S. L. TANDON and B. M. KAPOOR, Delhi

The importance of endosperm as the main source of nutrition for the embryo is well known. While a considerable amount of work has been done on the morphology and physiology of this tissue, very little is known about its cytology. The knowledge of the behaviour of nuclei and chromosomes in endosperm is essential to find out the causes of variation in nuclear size and the failure of endosperm which leads to abortion of the embryo.

In *Vicia faba,* the endosperm remains free nuclear throughout the course of its development. It develops a chalazal haustorium as it grows. There is a striking variation in size and shape of nuclei. Giant nuclei, branched nuclei, dumbbell shaped nuclei, highly extended nuclei and micronuclei were commonly observed. In general, the nuclei in the haustorium are bigger than those of the rest of endosperm. The number of nucleoli per nucleus ranged from three to ten. Amitosis and fusion of nuclei were very frequent throughout the course of endosperm development. Mostly two nuclei were found to fuse. In some instances three or even four nuclei were involved in the fusion.

The haploid and diploid chromosome numbers of *Vicia faba* were determined as 6 and 12 respectively. In the beginning most of endosperm nuclei were found

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to be triploid (3n=18). Later, as the development proceeded, 5-ploid, 7-ploid, 8-ploid and 12-ploid nuclei were observed along with the triploid ones. In addition to the polyploid nuclei, several nuclei showed aneuploid chromosome numbers (19, 20, 21). Stages of endomitosis including diplo-chromosomes were recorded. The existence of 6n and 12n nuclei within the same endosperm suggests the occurrence of endoreduplication. The giant nuclei may, thus, be the result of endopolyploidy. There is no evidence for the occurrence of polyteny in *Vicia faba*.

The presence of multiple bridges, laggards and fragments suggests the operation of breakage-fusion-bridge cycle of McClintock (1941). Our observations show that polyploidy, aneuploidy, nuclear fusion and amitosis have caused variation in the size and shape of nuclei in the endosperm of *Vicia faba*. The cytological abnormalities reported in this paper were probably reseponsible for the failure of endosperm which led to abortion of the embryo ultimately resulting in reduced fertility.

222. Nuclear variation, polyploidy and chromosomal aberrations in the endosperm of *Nothoscordum fragrans* Kunth.

S. L. TANDON and B. M. KAPOOR, Delhi.

The paper deals with the cytological investigations on the endosperm of *Nothoscordum fragrans*. The endosperm remains free nuclear up to 8 days after pollination. The nuclei are normally of large size with clear granular chromatin. Intermixed with these nuclei are present giant nuclei with heterogeneous chromatin content. Various shapes of nuclei like dumbbell shaped, spindle shaped, extended nuclei, lobed nuclei and micronuclei were seen. Among these were also present the nuclei connected with wiry strands representing convincingly the stage of amitosis. After 9 to 10 days when the wall formation commences two or more than two nuclei may be included in a single cell forming binucleate or multinucleate cells. These nuclei later on fused resulting in polyploid ones. The number of nucleoli per nucleus ranged from one to twenty.

The haploid chromosome number of the plant was found to be 9 and 10. The diploid number, as determined from the root tips, is 2n=19. Obviously there could be two types of pollen grains, some having n=10 and others n=9. Depending upon the type of male gamete fusing with the polar nuclei, various chromosome numbers like 27, 28, 29 and 30 are expected in the endosperm. Of these nuclei with 3n=27, 29 and 30 have been encountered. Morphologically the chromosomes are extremely large with median and subterminal centromeres. They were V- or rod shaped depending upon the location of centromere. During the later stages of development, hexaploid, octoploid and even higher polid nuclei were encountered. The occurrence of hexaploid nuclei with diplochromosomes suggests the existence of endopolyploidy. One of the causes for the formation of giant nuclei was, thus, found to be endomitosis. In no case did we find a polytenic nucleus. Aneuploid nuclei were also recorded. The frequency of the occurrence of these nuclei was, however, very low.

Of the many derangements of mitosis may be mentioned the anaphases with multiple bridges, laggards, fragments and chromosome breakages. The occurrence of such abnormalities indicates the functioning of breakage-fusion-bridge cycle of McClintock. These aberrations may also be responsible for the low seed setting of the plant (87 per cent). Details of the cytology of endosperm in relation to its exact age are being worked out.

223. Fasciation in *Achyranthes aspera* L.—A Mutation.

V. THAKUR, Patna.

The phenomenon of fasciation is hereby described in *Achyranthes aspera*, L. The main or the middle inflorescence, which is usually affected, becomes flattened

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or ribbon-shaped at its tip bearing sterile flowers in the same fashion as is seen in *Celosia cristata,* Linn. The appearance of fasciation in a definite manner and absence of any pathological sign indicate that it is due to gene mutation; for, also, there is no difference in chromosome number or otherwise from the normal one. Fasciated *A. aspera* plants are not frequent in nature for they are not in cultivation and they are eliminated in wild due to production of insufficient amount of seeds. Fasciation has also been reported in *Amaranthus speciosus,* L. Thus it is observed that the family Amaranthaceae contains many closely related genera having parallel heritable variations.

224. Cytological studies in *Solanum nigrum* complex. I. Pachytene chromosome morphology and meiosis in diploid *Solanum nigrum* L.

J. VENKATESWARLU and P. V. BHIRAVAMURTY, Waltair.

A detailed study of the chromosome morphology at pachytene in diploid form of *Solanum nigram* (2n=24) growing as a common weed in India has been undertaken for a better understanding of the interrelationships of the members of the *Solanum nigrum* 'complex5. The twelve bivalents at pachytene have been identified individually on the basis of (i) length, (ii) arm ratio and (iii) extent of euchromatic and heterochromatic segments on either side of the centromere. Quantitative data on subsequent stages of meiosis have also been gathered and found that meiosis is normal. The pachytene chromosome morphology has beenn compared with the different species of the genus *Solanum* investigated by Gottschalk (1954) and also with that in *S. nodiflorum* Jacq., (2n=24) which is also studied by us. It is concluded that *S. nigrum* seems to be different from *S. nodiflorum* on the basis of morphology of the pachytene chromosomes and that the two species are distinct.

225. Meiosis in diploid and colchicine induced tetraploid *Zebrina Pendula* chnizl., A structural hybrid.

J. VENKATESWARLU and P. NARASIMHA RAO, Waltair.

Detailed study of the various phases of meiosis in diploid *Zebrina pendula* Schnizl. (2n=24), a structural hybrid, has been made. At diakinesis and metaphase 1, chains and rings of 3, 4 and 6 chromosomes are found frequently due to segmental interchange. The maximum associations observed in a cell are two chains of 6 chromosomes each. Not more than two higher associations are formed in any cell. Bridges with and without fragments, irregular distribution at anaphase, laggards, univalents and micronuclei are the abnormalities commonly met with. Pollen sterility is very high. The probable origin of the diploid is discussed. Through colchicine treatment the chromosomes in the above have been doubled and a tetraploid (4n=48) with reference to the structural hybrid is obtained. A study of meiosis in the induced tetraploid has shown only bivalent formation. This has been inferred as due to preferential pairing taking place between completely homologous chromosomes furnished by the duplication of the genome brought about by colchicine.

226. Differentiated chromosomes in morning glory, *Ipomoea Carnea* Jacq.

J. VENKATESWARLU and T. V. RAMANA, Waltair.

Ipomoea carnea belonging to the natural order Convolulaceae has been cytologically studied especially with reference to the morphology of the pachytene chromosomes. The chromosome number of n=15 reported by Rao (1947) is confirmed in the present study.

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All the pachytene chromosomes are characterised by being differentiated into heterochromatic and euchromatic regions, the former occupying the adjacent regions on either side of the centromere while the latter occupy the more distal regions of the chromosomes. The individual chromosomes can be readily identified at this stage on the basis of their length, position of centromere (arm ratio) and the extent of distribution of the hetero- and euchromatic regions on the respective chromosomes. A key to the diagnostic morphological features of the 15 pachytene bivalents has been made on the basis of data collected from a complete analysis of 10 nuclei, in each of which the individual chromosomes could be identified. One of the bivalents is seen in association with the nucleolus with a terminal or nearly terminal nucleolus organising body. The longest chromosome of the complement measures 67 microns and the shortest measures 36 microns on an average. All the chromosomes are submedian or nearly so.

There is a localisation of the chiasmata in the euchromatic regions and the average chiasma frequency comes to 17·5 per nucleus at diakinesis. Metaphase I could not be analysed due to inordinate clumping of the bivalents on the equatorial plate. Anaphase I and telophase I and second division of meiosis are quite normal and regular.

227. Cytological studies in *Euchlæna mexicana* schrad. (Annual teosinte).

J. VENKATESWARLU and T. V. RAMANA, Waltair.

A locally grown strain of *Euchlaena mexicana,* raised in the Government Dairy Farm for fodder purposes, is cytologically studied with respect to the morphology of pachytene chromosomes, meiosis and somatic karyotype.

On the basis of morphological data collected quantitatively the ten pachytene bivalents which are characterised by their length, position of centromere and knobs, have been identified and a key to their diagnostic features is presented. The longest and shortest chromosomes of the complement measure 89·6 microns and 32·6 microns respecetively. All the chromosome arms except the short arms of chromosomes 6 and 10 have terminal knobs. The knob on the short arm of chromosome 7 is wedge shaped while that in the short arm of chromosome 8 is elongated and these two knob types are recorded for the first time. The 6th chromosome, arranged in the descending order of length, is the nucleolus organising chromosome and has a nearly terminal satellite in its short arm. Except chromosome 5 which is median, all the rest are submedian or subterminal.

A complete analysis of 60 diakinetic nuclei showed the average chiasma frequency to be 20·3 per nucleus with a terminalisation co-efficient of 0·39. Further stages of meiosis are normal and regular.

The arm ratios obtaining at the pachytene are reflected in the somatic chromosome pairs, one of which (sixth) is clearly satellited. The longest somatic chromosome measures 9·13 microns and the shortest 1·43 microns.

Longley (1937) investigated the pachytene chromosomes of seven American strains of annual teosinte and reported occurrence of internal knobs on the basis of which he suggested gross chromosomal admixture of teosintes studied by him, with maize. In the material investigated here, besides differences in chromosome lengths, internal knobs are found to be conspicuously absent.

228. Pachytene chromosome morphology and affinities of *Nicandra physaloides* var. *Immaculata* (L) Gaertn.

J. VENKATESWARLU and B. G. S. RAO, Waltair.

The ten pachytene bivalents of *Nicandra physaloides,* var. *immaculata* have been identified, described and a key to their identification has been made on the

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basis of morphological data collected quantitatively. All the chromosomes are characterised by being differentiated to varying extents into euchromatic and heterochromatic regions which facilitate easy identification of the individual chromosomes of the complement.

The isochromosome pair with satellites on either arm reported by Darlington and Janaki Ammal (1945) in materials investigated by them is not met with in our material and only a single nucleolus organising bivalent is included in the complement. In 1954, Gottschalk investigated the morphology of pachytene chromosomes in *Nicandra physaloides* and of the nine chromosome types reported by him, six are common with those of the present investigation in their basic pattern. This suggests that probably there is variation in the morphology of pachytene chromosomes in the different varieties of the genus.

Synopsis and disjunction at the respective meiotic stages are normal and regular, resulting in four haploid microspores.

On the basis of similarities of the pachytene chromosomes, *Nicandra* seems to be more nearly related to *Lycopersicum* than to other genera of the family Solanaceae.

229. Meiosis in *Sorghum morgaritiferum* stapf.

J. VENKATESWARLU and V. R. K. REDDI, Waltair.

A study of the morphology of pachytene chromosomes of *Sorghum margaritiferum* Stapf. (2n=20) shows that there are four homologues for each of the five chromosomes of the complement including a nucleolus organising chromosome characterised by terminal satellite. These form associations of two each or all four of them are involved in an association, pairing taking place between any two of them at a given point. In the latter case, the association shows exchange of partners at one or two places. Consequent upon the formation of appropriate number of chiasmata at the appropriate places, multivalent formation takes place. A detailed and complete analysis of 24 diakinetic nuclei shows that quadrivalent types 11, 15, 17 and 18 are encountered and types 11 and 17 are more frequent. The average quadrivalent frequency varies in different nuclei from 5 down to 2 with average value of 3·71 per nucleus. The average chiasma frequency is found to be 19·71 per nucleus at diakinesis.

On the basis of the high quadrivalent frequency, the numerically unbalanced distribution of the chromosomes at anaphase I, frequent formation of laggards and the associated high amount of pollen sterility, it is suggested that the investigated material is a natural autotetraploid.

MISCELLANEOUS

230. Pharmacognostic studies on the stem barks of *Michelia champaca* Linn.

RAI H. N. CHAUDHURI, Calcutta.

The paper deals with the detailed macroscopical and microscopical studies on the stem bark of *Michelia champaca* Linn. which is one of the important bark drugs of our country. The stem bark is used for various ailments and can also be considered as an excellent substitute for guaiacum. The longitudinal fissures on the outermost layer of the bark which on drying separates like a hard crust and with greyish brown projecting fibres on the fractured surface are the chief diagnostic characters from the macroscopic point of view. The presence of stone cells with large lumen, secretory cells with mucilage and the prismatic and octahedral

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crystals of calcium oxalate in the cortical and phloem region and the phloem fibres with bluntly pointed ends and with very small lumen, are the chief diagnostic characters from the microscopic point of view by which this bark drug can be easily identified.

231. A Preliminary study on ethnobotany of some parts of Madhya Pradesh.

S. K. JAIN, Allahabad.

The interior remote hilly tracts covered by dense forests and sparsely populated by human habitation are interesting spots for a study of the natural relationship between vegetation and man. Some such locations have been studied in Mandla, Balaghat, Chhindwara and Bastar districts in Madhya Pradesh.

The plant products i.e. forest produce and the agricultural produce govern the economy of these areas. Several villages are named after their chief plant produce e.g., 'Harragaon' (*Terminalia chebula* Retz.) and 'Raigaon' (*Brassica juncea* Czertn. & Coss.).

These tribal people still practise 'Bewar' system of cultivation though on a much restricted scale. They grow *Cajanus cajan* (L.) Millsp., *Panicum miliare* Lam., *Paspalum scrobiculatum* L., *Pennisetum typhoides* Stapf & Hubb., *Sorghum vulgare* Pers. and *Zea mays* L.

They also raise some vegetables etc. in a small enclosure attached to their houses 'Bari'. *Brassica juncea* Czertn. & Coss., *Capsicum frutescens* L., *Dolichos* spp., *Luffa acutangula* Roxb., *Lycopersicum esculentum* Mill., *Mamordica charantia* L., *Nicotiana tabacum* L. and *Ricinus communis* L. are commonly grown.

These tribals use a variety of wild growing plants for their food and other domestic needs.

Plants used as food are :—Tubers of *Curcuma angustifolia* Roxb., *Dioscorea hispida* Dennst. etc., leaves of *Bauhinia malabarica* Roxb., *B. purpurea* L., *Cassia tora* L., *Centella asiatica* (L.) Urban., *Cordia dichotoma* Forst. f., *Indigofera pulchella* Roxb., *Moringa oleifera* Lam., *Rivea hypocrateriformis* Chois., fruits of *Aegle marmelos* Correa., *Bauhinia* spp., *Boswellia serrata* Forst. f., *Diospyros* sp., *Emblica officinalis* Gaertn., *Ficus glomerata* Roxb., *Gmelina arborea* Roxb., *Madhuca indica* Gmel., *Mangifera indica* L., *Randia dumetorum* Lamk., *Syzygium cuminii* Skeels.

Bauhinia vahli W. & A. and *Pennisetum alopecurus* Nees are used for cordage. *Cleistanthus collinus* Benth. and *Sphaeranthus indicus* L. are used as fish poison. The inflorescence of *Thysanolaena maxima* Ktze. provides the broom sticks.

A large number of plants are employed for curing disease, some for their medicinal value and others for their supposed magical actions. The area is being further studied.

232. Pharmacognostic Evaluation of the Plant *Asterachantha longifolia* Nees.

P. K. SANYAL and P. N. VARMA, Calcutta.

Asteracantha longifolia Nees (Family Acanthaceae) known as "Kulekhara" in Bengal is an annual spiny herb found throughout Bengal and scattered all over India. It grows up to one meter high in moist and marshy places.

Two varieties were found in plains of West Bengal, having practically the same morphological characters. The only difference which could be observed was the difference in colouration of the flowering tops. When separated into different parts a plant has approximately roots —8·4%, stem 6·5%, flowers 19·6%, leaves 7·0%.

The moisture content, ash content including acid insoluble ash, water soluble ash and sulphated ash were determined. The average moisture content of dried

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plant was 7·4% and of fresh plant was 74·0%, while the average ash content was 11·5% for both fresh and dried. The extractives of the plant like alcohol soluble extractive, water soluble extractive, chloroform soluble extractive and petroleum ether soluble extractives were determined showing that water soluble extractives were the largest.

The chemical constituents were also determined for the whole plant as well its individual parts like root, stem, leaves and flowers, specially for its content of alkaloids, sugars, polysacchrides and sterols. Though positive reaction of alkaloids were obtained from the fresh plants—no such reactions were obtained from the dried plants kept for more than six months.

A summary of the presence of important chemical constituents from different parts of fresh plants is given below.

Preparations (Fresh plant only)	Alkaloids	Sugars	Poly-saccharides or glucosidal bodies	Sterol
50% Alcohol macerated ext. ...	+ve	+ve	+ve	+ve
95% Alcohol macerated ext. ...	+ve	−ve	−ve	+ve
Decoction (I.P.C. method) ...	−ve	+ve	+ve	−ve
Roots only in 50% alcohol ...	+ve	+ve	?	++
Stems only in 50% alcohol ...	+ve	+ve	+ve	+ve
Flowers only in 50% alcohol ...	−ve	+ve	+ve	+ve
Leaves only in 50% alcohol ...	−ve	+ve	+ve	−ve
Juice of the fresh plant ...	−ve	+ve	+ve	+ve

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SECTION OF ZOOLOGY AND ENTOMOLOGY

President :—Dr. L. S. Ramaswami, D.Sc., F.Z.S.

Abstracts.

CYTOLOGY & GENETICS

1. The rate and site of Mitosis in embryonic chick auricle.

N. BEGUM, Calcutta.

The rate and site of the mitotic phenomenon operating in the auricular region of chick during different stages of development have been worked out. The study has revealed that all cells of the cardiogenic field do not undergo division at a time, but there is a sign of distinct mitotic frequency which swings until completion of incubation. Highest rate of mitosis is 8·74% which has been observed in the 19 day embryo, the lowest being 1·38% in the 15 day embryo. Between these two extremities, the mitotic frequency of chick auricular material fluctuates. Though there is no definite mitotic centre, the middle sector of the auricular material happens to be mitotically more active. Comparing the present investigation with the previous study of the ventricular indices by Mookerjee and Begum it is now abuntantly clear that the rate of mitotic activity is much greater in ventricle as a whole. The role of mitosis in the process of individuation has been discussed.

2. Mammalian Chromosomes *in vitro* on the Marker Chromosomes and Chromosomal Polymorphism of Strain L-P 59.

G. K. MANNA, Calcutta.

A sample from the strain L-P 59 obtained through the courtesy of Dr. T. C. Hsu, M.D., Anderson Hospital. University of Texas, Houston, Texas, was studied cytologically and the results have been presented in the paper.

The cell stain had a mysterious origin and a heterogeneous chromosomal constitution. The chromosome numbers vary between 57 and 71 with the mean value of 64·188 chromosomes. The characteristic D-chromosomes in the parental strain L-P 55 were of higher incidence which in the present derivative strain L-P 59 are not only lower in frequency but also have undergone various types of transformations. The cell population has the mean values of 13·84, 2·08, and 47·50 for metacentric, submetacentric and acrocentric chromosomes respectively. The data have further shown that the increase in the acrocentric chromosome number is responsible for the increase in the chromosome number in the complements.

The data have been compared with those of the parental stock and their cell line derivatives, and the importance of chromosomal polymorphism in the evolution of the different caryotypes of different cell strain has been discussed.

3. A Study of the Annual Reproductive Cycle of the Indian Koel, *Endynamis scolopaceus* (Linnaeus) at Varanasi.

C. J. DOMINIC, Varanasi.

The annual reproductive cycle of the Indian Koel, *Endynamis scolopaceus*, a social parasite on two species of crows (*Corvus macrorhynchos* and *C. splendens*)

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is studied. *C. macrorhynchos* (the jungle crow) breeds during March-April and *C. splendens* (the house crow) breeds during May-June. The peak of the reproductive cycle of the koel lasts from March to June, and this extended breeding season covers the breeding seasons of the two species of crows, in whose nests it deposits its eggs. During the months of March, April, May and June, the testes of the koel usually contain spermatozoa in bundles and also free spermatozoa in the lumina of the seminiferous tubules. The ovary also shows maximum of activity and ova in advanced stages of yolk formation are common during these months. In many individuals, the ovary contains post-ovulatory follicles, showing that ovulation has taken place recently. Some of the larger follicles exhibit bursting atresia, as a result of which yolk globules and phagocytes are present in the ovarian stroma. In a few cases the oviduct contained eggs also. Regression of the gonads set in July, when the contents of the seminiferous tubules in the testes become sloughed off leaving behind only a few rows of spermatogonia. In the ovary most of the remaining larger follicles turn atretic. By September regression of gonads is completed. The gonads remain in the resting condition from October to January. By the second half of January the gonads begin to show signs of recrudescence and at the end of February spermatozoa appear in the testes. In the ovary follicles increase in size rapidly and by the middle of March mature ova are found. Thus the timings of the annual reproductive cycle of the Indian koel corresponds more or less closely to those of its hosts, viz. *C. macrorhynchos* and *C. splendens*. Hence the breeding season of the koel is dependent on an "external proximate cause", *viz.* the nesting periods of the two species of crows already mentioned.

4. On the Motility of Avian Spermatozoa.

P. N. MEHROTRA, Ranchi.

Very few observations have been made on the capacity of independent movement possessed by the spermatozoa of birds or even other vertebrates. An examination of sperms taken from the seminiferous tubules of *Anser anser, Passer domesticus, Copsychus saularis* and *Saxicoloides fulicata,* in physiological saline revealed that they lacked a capacity of independent movement. An identical examination was made of the sperms taken from the epididymal tubules and it was seen that these sperms possess an independent capacity of movement. My observations are, therefore in disagreement with that of Munro (1935) who reported slight motility in the sperms of fowl taken from the testis tubules. The sperms of the birds examined by me did not have any capacity for movement while in the testis tubules.

It was also observed that corresponding to the progressive and reproductive phases of the testis cycle of *Anser anser,* the lining epithelium of epididymal tubules show much secretory activity and the lumina of the epididymal tubules are full of secreted droplets. It seems highly probable that the acquisition of motility by the avian sperms in the epididymis may be due to the action of the epididymal secretion.

5. On the Amitotic Division of Interstitial Cells in the Testes of *Anser anser.*

P. N. MEHROTRA, Ranchi.

The present paper gives an account of amitotic division of the interstitial cells in the testis of *Anser anser.* The process of amitosis as it occurs in the metazoa has been insufficiently investigated and it is hardly known how frequently it occurs and whether it is to be regarded as normal or abnormal. Generally it is believed

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that amitosis is of rare occurrence and takes place in the cells which are in the early stages of degeneration and are losing their power of division or in the highly specialised cells. Some authors maintain that amitotic division in a nucleus brings about a fatal derangement in them and renders them incapable of further multiplication.

The interstitial cells in the testis of *Anser anser* undergo active division by *amitosis* and *cryptomitosis*, during the progressive phase of the testis cycle in the months of October and November.

During amitotic division of the interstitial cells, the nucleus elongates and a constriction appears in the middle giving it the appearance of a dumbbell which draws into two. The two halves separate and move apart from each other. All the stages of nuclear division can be clearly seen. The cytoplasm then becomes divided between the two daughter nuclei, thus giving rise to two cells. Thus amitotic division of the nucleus should not always be taken as an evidence of degenerative character of the cell. It is resorted to by the interstitial cells probably as a contrivance for their rapid multiplication. I cannot say whether the daughter cells produced by the amitotic division of the interstitial cells in the testis, undergo further division or not. However it is true that the interstitial cells of the testis are highly specialised cells with a limited life, performing their function during a certain period and then losing their activity.

During cryptomitotic division of the interestitial cell nuclei, a spindle is present but distinct chromosomes are not formed. The chromatin becomes concentrated into a mass at the equator of the spindle and divides into two smaller masses which move to the opposite poles.

6. An analysis of the Chromosome Complements in five species of the Indian Spiders belonging to sub-family Lycosinae.

OM PARKASH MITTAL, Chandigarh.

The analysis of chromosome mechanism in five species of the Indian spiders belonging to two genera of the sub-family Lycosinae is presented below in a tabular form :—

TABLE

No. Species	Diploid number of chromosomes	Number of chromosomes at metaphase I	Number of chromosomes at metaphase II	Sex chromosomes
Genus *Lycosa*				
1. *Lycosa chaperi* Simon	22	12	12. 10	XXO-unequal
2. *Lycosa himalayensis* Gravely	28	15	15. 13	XXO-unequal
3. *Lycosa madani* Pocock	24	13	13, 11	XXO-unequal
4. *Lycosa* sp. nov. ..	28	15	15. 13	XXO-unequal
Genus *Pirata*				
5. *Pirata latitans* (Blackwall) ..	24	13	13, 11	XXO-unequal

The general course of meiosis is typical and is more or less uniform in all the five species.

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All the chromosomes are acrocentric without exception. The two X-chromosomes are unequal in all of them and form a separate accessory plate during metaphase I. Both the X-chromosomes go undivided to one pole during meiosis I, showing precocious movement.

The chiasma frequency is usually low in all the spiders and each bivalent generally carries a single chiasma.

7 . Contributions to the Cytology of Scorpions.

M. R. RAJASEKARASETTY and C. B. VENKATANARASIMHIAH, Mysore.

Preliminary studies on the cytology of the scorpion palamnaeus-gravimanus reveal that the haploid number of chromosomes is 56. Phase-constrast microscopic studies on the spermiogenesis brought out the following points of interest. As found in other scorpions like centrurus and Buthus acute-carinatus the mitochondria do not coalesce and form large mitochondrial ring in *P. gravimanus*. On the contrary they do not fuse till the late spermatid stage when they form the middle piece. 2 sometimes 4 spermatic nuclei are found in a common cytoplasmic mass indicating that at least in some locules cytokinesis does not follow nuclear divisions. However there is a consumation of normal spermiogenesis in these locules. If failure of cytokinesis is attributed to rapid meiotic division, one still has to account for the reason as to why it is so in some divisions and not all. As it is reported elsewhere (Rajasekarasetty 1951 and 1954) even normally fertile males produce morphologically abnormal sperms in *Mus musculus*. It is interesting to note that in *P. gravimanus*, in the spermiogenesis certain anomalies are evident. Broadly two abnormalities can be noted in a few spermatids undergoing spermiogenesis. First is the failure of the spermatid nucleus to move to the future anterior pole before condensation of the nuclear matter begins. This results in the condensation and elongation of the nucleus within the confines of the cytoplasm. The shape of the nucleus is half crescent when it should be long and erect. The second anomaly is the failure of mitochondrial rings to congregate at the posterior end of the sperm nucleus,—two or more may partially attach themselves to form open chains which are scattered in the cytoplasm at a stage when they should have arranged themselves to give a beaded ring appearance. Further in certain locules it was found that while the nucleus has normally transformed into a long filamentions head, the mitochondria are still in a condition comparable to midspermatic stage. Further in some case, only one mitochondrium is attached to the posterior region of the nucleus while the rest of them are sloughed off into the trailing cytoplasm. The anomalies result in middle piece abnormality resulting in atypical sperm formation. The studies on the role of Golgi bodies in spermiogenesis are in progress.

8. Parthenogonic Haploid Embryos in the Grasshopper, *Aiolopus* sp.

S. P. RAY-CHAUDHURI and T. SHARMA, Varanasi.

Virgin females of *Aiolopus* sp. laid 282 eggs. A sample of 41 eggs was dissected on the 13th and 14th day of laying for a study of the chromosomes in the neuroblast cells. Thirteen of them showed no development, twenty five had partial development and only three showed large number of normal neuroblast cells in division. The cells in these embryos were predominantly haploid with some diploid cells, the frequency of the latter varied in different individuals. Out of the remaining 241 eggs only two hatched and both of them were females thus showing that grasshoppers also have *Drosophila* type of sex determination. Cytological evidence of a probable mechanism of the origin of diploid parthenogonic males was found and has been described in the paper.

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9. A Study of the Chromosomes of *Notopterus notopterus* (Pallas), Notopteridae.

H. K. SAKSENA, Saugor.

The chromosomal counts made on the spermatogonial metaphase plates of *Notopterus notopterus* for the diploid number reveal 48 chromosomes of different shape and size. The structural difference of chromosomes is well displayed by V, J and rod shapes.

The V's have median attachment but the J's are with sub-median and the rods with terminal attachment. In the rod shaped chromosomes one pair is much smaller than the rest which are more or less of the same size.

The primary and secondary spermatocyte metaphase plate counts reveal that the haploid number is 24. In the primary spermatocytes the bivalents are more conspicuous and take deeper stain than the chromosomes in the spermatogonia. The chromosomes of the secondary spermatocytes appear as small rounded dyads.

The number of cromosome complement of *Notopterus notopterus* (Fam. Notopteridae) is similar to that of *Belone cancila* (Fam. Scombresocidae) both as regards diploid and haploid numbers which are 48 and 24 respectively as well as in the number of V's, J's and r's.

10. Cytological and Cytochemical Studies of the Sexual Cycle of Male Indian Sparrows.

ASIT KUMAR SARKAR, Calcutta.

1. The sexual cycle of Indian house sparrow (*Passer domesticus*) with the seasonal changes in accessory reproductive organs has been studied.
2. The active period ranges from October to July, while August and September are the months of sexual inactivity.
3. Different type of germinal elements have been counted in different months and five histologic stages in testicular cycle have been recorded. The interstitial cells have also been quantitated throughout the cycle.
4. The role of indiscrete mass as well as sertoli cells in the process of sperm release has beenn indicated.
5. The accessory reproductive organs have been thoroughly studied. The accessories undergo a marked seasonal variation histologically.
6. Four cytologically distinct epididymal tubules have been described in the sparrow epididymis. One particular type of epididymal tubules and the seminal vesicle are the storage organs of sperms. The latter is also highly secretory in nature.
7. The localization and distribution of alkaline phosphatase and ascorbic acid in the testicular germinal elements and the former in sex accessories have been reported.
8. Cholesterol is totally absent from the testis. The sudanophilic lipids are present around the sperm bundles which probably act as a nutritive reservoir for the sperms.
9. The staining of the acrosomic system of the spermatid with the PA-Schiff technique beautifully shows the genesis of the head cap in this species.
10. Glycogen and metachromatic substances are very scantily distributed in the whole male reproductive system.
11. The control of testicular cycle in this avian species has been interpreted in the light of modern endocrinological researches. Along with this the probable role of histochemical entities throughout the reproductive cycle has been pointed out and discussed.

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11. Effect of Starvation and Dehydration on X-ray induced Chromosomal Non-disjunction in *Drosophila melanogaster*

S. K. SINHA, Cuttack, Orissa.

The effect of starvation on the frequency of x-ray induced non-disjunction of the X chromosome of *Drosophila melanogaster* has been investigated to determine the extent of genetic damage due to irradiation of individuals with subnormal body metabolism. The breeding scheme used for the purpose was suggested by Muller. Virgin flies of the specially synthesized achete (ac^3)—Bar (*B*) stock (ac^3 marking the X chromosome and *B* carried by a small translocated X chromosomal fragment marking the Y chromosome, also attached to another small fragment carrying the normal alleles of ac^9 and *y* for yellow body colour) were either kept on normal media or cut off from food and water for 18 hours. The flies of the two series were next subjected to X-irradiation of 1000r, 2000r and 4000r and mated to male flies of another specially synthesized yellow (*y*)—Bar (B) stock obtained similarly as the ac^3-B one. Non-irradiated flies in both series served as controls for the effect of irradiation.

In the control series (normally fed) the degree of non-disjunction increased progressively though disproportionately with enhanced dosage. In the 'starved' series much higher degree of non-disjunction was observed at 1000r compared with that in the normally fed ones. Surprisingly enough, non-disjunction in the 'starved' series was much lower at 2000r than that of the control series treated with the same dose of x-ray, and non-detectable at 4000r. Besides the evident fact that starvation and dehydration renders the individuals more susceptible to radiation damage, the relationship of dosage to non-disjunction in 'starved' flies is quite interesting. A simultaneous and remarkable decrease in the number of offsprings of the 'starved' series subjected to higher dosage seem to suggest the possibility of simultaneous non-disjunction of more than one chromosome leading to greater chromosomal imbalance and consequent elimination of the non-disjunctional offsprings as the probable cause of such anomaly. The problem of simultaneous non-disjunction of more than one chromosome is being further explored in *Drosophila* as well as in another organism, *Zea mays*.

ECOLOGY

12. Microclimate in the burrow of the Indian desert gerbil, *Mariones hurrianæ* Jerdon.

ISHWAR PRAKASH and C. G. KUMBKARNI, Jodhpur.

Temperature variations inside the burrow of the Indian desert gerbil, *Meriones hurrianae* were observed with the help of Philips rod thermistors and soil moisture temperature bridge. The thermistor was introduced into the burrow by tying it to the tail of the gerbil. As soon as gerbil rested in the burrow, it got rid of the thermistor by biting the thread off. Thermistors were rarely damaged.

Temperature readings were taken at 50, 100 and 150 cms. horizontally deep inside the burrows. On a hot day the temperature inside the burrow was on an average 6·4°C (±1·0°C) lower than the surface temperature while on a rainy day it was about 4·5°C (±0·7°C) lower than the surface temperature at 50 cms. but the temperature was 3·5°C (±1·0°C) higher at 100 and 150 cms. The temperature variations at 150 cms. fluctuate between 0·5°C (±0·3°C).

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13. Food consumption and adequate bait for Desert Gerbil control.

ISHWAR PRAKASH and C. G. KUMBKARNI, Jodhpur.

Food consumption of *Meriones hurrianae* Jerdon varies from 4 to 5 gms. in 24 hours. The quantity consumed, however, depends on the quality of food. They did not prefer seed diet in captivity. Seeds of 15 plants (*Tecomella undulata, Prosopis spicigera, Prosopis juxiflora, Zizyphus numularia, Cenchrus setigerus, Cenchrus ciliaris* etc.) growing in gerbil habitat were tried individually and in mixtures. Trials were made on single gerbil and also in groups. Amongst cereals, wheat and millet were most preferred. Wheat flour was also preferred and can be used as a suitable bait for poisoning the Indian desert gerbil, *Meriones hurrianae*.

14. Toxicity, relative acceptance and lethal dose of certain poisons for the Indian desert gerbil, *Meriones hurrianæ* Jerdon.

ISHWAR PRAKASH and C. G. KUMBKARNI, Jodhpur.

Toxicity of various poisons was estimated by oral administration with the help of a hypodermic syringe fitted with a flexible stomach tube. Zinc phosphide is very toxic for *Meriones hurrianae*. An oral dose of 25 mg. in aqueous suspension caused 100% mortality in 3 to 3½ hours. Similarly 50 mg. of Arsenic trioxide killed gerbils in 10-12 hours and 250 mg. of Barium carbonate in 5 to 6 hours.

The relative acceptability (or repellency) of the poisons was measured by the reduction in food intake. There was very little difference in the food intake when Zinc phosphide was administered in concentrations up to 1% of the total bait but at 3%, its acceptability was very low. Arsenic trioxide was unpalatable at 2% concentration but Barium carbonate was readily accepted up to 5% concentration and 10% Barium carbonate was less acceptable. Rodeth and Ratafines were comparatively more acceptable.

The modes of death due to various poisons have been described.

EMBRYOLOGY

15. Seasonal reproductive cycle of the female toad, *Bufo melanosticius* Schneid.

S. L. BASU, Calcutta.

More than three hundred (300) female toads were examined during the period of 1960-61, collected from Calcutta and its suburbs. Body weight, Snout to vent length and weight of both the ovaries were recorded. Some of the ovaries were thoroughly examined morphologically under binocular microscope and others were fixed for proper histological preparations. For convenience they were classified into five different stages according to the predominance of the number of eggs *as per* the following criteria—

Stage I—Small unpigmented ova. Primary Oöcyte in syngenesis. Accumulation of yolk granules round centrosome at one side of the nucleus.

Stage II—Variable pigmentation and small eggs. Chromatin filaments achromatic and nuclei increases in number of fragmentation.

Stage III—Uniform pigmentation, medium sized eggs. Expanded nucleus with saccular nuclear membrane.

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Stage IV—Distinction between animal and vegital pole. Medium sized eggs. Dissolution of the nuclear membrane and mixing up of the nuclear material with the cytoplasm.

Stage V—Large eggs with marked pigmentation in the animal pole. Chromosomal mass migrated to animal pole for first polar spindle in primary position.

Post ovulatory ovary was detected mostly during the period of July-August and also during February-March. Ovarian weight rapidly increases during the months of November-December and May-June . The Oögenesis continues throughout the year having the nuclear explosions, yolk accumulations and gradual pigmentation forming the animal and vegital poles. The thickenings, convolutions and well-developed nature of the oviducts depend on the maturity of the ovary as well as the ovulatory season.

The present study further reveals that *Bufo melanostictus* is able to spawn throughout the year. Environmental temperature and humidity seem to be the guiding factor of the reproductive pattern of this common Indian toad. It was noted that the rainy or cloudy days of December caused the rise of humidity and temperature during the winter months which leads to the oviposition of toads in nature. It has also been observed to spawn spontaneously without the presence of males in the laboratory.

16. The development of Cephalic Arteries in *Mastacembelus armatus* (Cuv. & Val.).

HARIHAR NATH BHARGAVA, Saugor.

The development of the cephalic arteries in *Mastacembelus armatus* is studied and described at 5·5 mm., 7·3 mm., 7·5 mm., 8 mm.. 9 mm. and 21·6 mm. length.

The development of aortic arches is studied. The first aortic arch is continuous in the developmental stages studied and represents the mandibular aorta. Its dorsal part represents the secondary afferent pseudobranchial artery of *Gadus* and the orbital artery of other fishes. The secondary afferent hyoidean artery arises as a backward extension of mandibular aorta and joins the ventral aorta. The development of this blood vessel is interesting in *M. armatus*.

The pseudobranch gets its blood supply through the mandibular aorta and is mandibular or spiracular in character. The type of blood supply of the pseudobranch is trigemino-pseudobranchial type of vascularisation. The pseudobranch remains respiratory in function for a long time due to its venous blood supply.

The opercular respiration is present in the larval stages of *M. armatus*.

17. Embryological studies on the connecting tissue of the heart of *Lepus ruficaudatus*.

PREM CHAND JAIN, Bhopal.

Embryology of the connecting tissue of the heart of *Lepus ruficaudatus* has been studied in serial sections. The heart shows the general characteristics of mammalian heart. However, the sinus venosus is present in early stages. Sinuatrial valves are absent while well developed valves are present at the openings of precaval and postcaval veins. In later stages of development the sinus venosus becomes completely incorporated into the right atrium. Sinuatrial node first to appear and its development is independent of the absorption of the sinus venosus. Atrioventricular node is not present in pre-natal hearts but appears only in hearts

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of new born and adult, in whom it is present as a spherical meshwork of 'Purkinje fibres' at the caudal end of interatrial septum. Multiple muscular atrioventricular connections are absent. Bands of 'Purkinje fibres' are present in the outer wall of the atria in the early stages of development presumably to distribute the contraction stimulus well over the atria. Atrioventricular bundle appears at later stages of development and is not well defined. Sinuatrial node, Atrioventricular node, Atrioventricular bundle, 'Purkinje fibres' and ordinary muscle fibres of the heart form the muscular conducting system of this animal.

18. The development of the Dermal Bones related to Latero-sensory Canals of the head in the fishes, *Ophicephalus punctatus* Bloch (Ophicephalidae) and *Wallago attu* Bl. & Schn. (Siluridae).

A. S. KAPOOR, Jodhpur.

The development of the dermal bones related to sensory canals of the head in *O. punctatus* and *W. attu* has been described. Two types of such bones can be distinguished—one, the 'canal bones proper' (*e.g.* the suborbitals), and the other two component type of bones (*e.g.* the frontal) composed of a membranous and a latero-sensory component. The membranous component of the latter type always ossifies far in advance of the latero-sensory component. It always develops in close vicinity of, and immediately below or behind the neuromasts of the lateral lines. The two components of these bones in both the fishes are fused with each other from the beginning. In *W. attu* the latero-sensory component usually develops at the time of invagination of the sensory canal. In *O. punctatus*, on the other hand, it develops only after the canal has attained its full development (except in the case of the preopercle and the posttemporal). There is no disintegration of the connective tissue layer below the neuromasts at the time of ossification of the membranous component, but its dissolution can invariably be observed to coincide with the invagination of the sensory canal.

The main conclusions derived on the basis of these investigations are : Neither the membranous nor the latero-sensory component owes its origin to the morphogenetic activity of the neuromasts; the value of the neuromasts in this respect is limited to that extent only in that they exert some kind of trophic influence for stimulating the ossification in their immediate neighbourhood; the invagination of the canal makes this faculty of the neuromasts much more manifest at the time of formation of the latero-sensory component; the osteoblasts do not have an ectodermal origin and the commonly observed picture suggesting a migration of the osteoblasts from the epithelium to the developing bone is deceptive; the latero-sensory component (as also the 'canal bones proper' which are truly equivalent to the latero-sensory component) in a certain region of the head may be altogether lost with the corresponding loss of the sensory canals of that region, and as such it is justifiable to homologize such bones as for example, the frontal, of the higher vertebrates (which has lost the latero-sensory component) with the same bone in the fishes; it is the intimate fusion of the originally independent latero-sensory component with the underlying bones in early phylogeny which has been responsible for the unquestioned constancy in the course of the various sensory canals through the cranial bones of the present day teleosts, and it is due to an abbreviation of the developmental processes that the ontogeny of these bones in these fishes does not give a complete picture of the phylogeny (*i.e.* one of independent origin and subsequent fusion of the latero-sensory ocmponent with the underlying bone), and the latero-sensory component simply 'grows' out from the fused structure.

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19. On the mode of formation of Latero-sensory Canals in *Ophicephalus punctatus* Bloch (Ophicephalidae) and *Wallgo attu* B. & Schn. (Siluridae) and the question of homology between the 'Teleostean' and 'Plagiostomian' Canals.

A. S. KAPOOR, Jodhpur.

The author has described the mode of development of the sensory canals in *O. punctatus* and *W. attu* and has observed that they are formed by a broad epidermal invagination in a manner characteristic for the teleosts. The question of homology between the sensory canals of the teleosts and the elasmobranchs has been discussed in detail and the author has collected evidences to invalidate the contention of Allis (which appears to go without contradiction till this day) that the 'plagiostomian' canal is the result of a dehiscence or deliquescence in the central portion of a solid cord of cells, formed by an involution of the deeper layers only of the ectoderm, while the 'teleostean' canal is the result of a much larger involution which involves the entire ectoderm, and both as such can not be treated as homologous structures. It has been argued by this author that it is not possible to accept the views of Allis on the basis of the following facts : that the very early stages of development of the typical teleostean and typical plagiostomian canals are similar; that in certain teleosts certain or all the canals follow the typical plagiostomian pattern of development, and conversely, certain of the elasmobranchs pursue the typical teleostean development; and finally, in certain teleosts the same canal may sometimes follow the typical plagiostomian and at others the typical teleostean mode of development.

20. On the functional development of right ovaries in certain birds.

P. N. MEHROTRA and K. C. BOSE, Ranchi.

The present paper brings on record the occasional presence of symmetrical, evenly developed and histologically similar paired ovaries in the female reproductive system of the Finchlark, *Eremopteryx grisea*. However only the left oviduct was present in these cases and there was no trace of the right oviduct. The oocytes of the right ovary surrounded by their follicular layers are similar to the follicles of the left ovary. Thus the right ovary is capable of developing to a fully mature condition. The ova produced in the right ovary must be passing out through the left oviduct.

Occasional presence of right ovary has also been reported in the fowl by His (1868), Chappelier ('14), Macklin ('23), Domm ('27), Brode ('28) and Macklin (823); in the pigeons by Riddle ('25); in the domestic ducks by Chappeliar ('14); in the English sparrow by Witshi ('55) and in the falcons by Stieve ('24). Synder ('31) and Stanley ('37) have reported the invariable presence of right ovaries in all the specimens of hawks, *Accipeter nisus* and *Accipeter velox*.

It seems highly probable that the occasional presence of right ovary in some specimens is due to a disturbance in their embryyonic development. As Witschi ('45) has stated, the usual nondevelopment of the right ovary in birds is due to an inherent deficiency in the inductor strength of the right gonad primordium, leading to an asymmetry in the distribution of germ cells to the two sides. It, therefore, follows that in *Eremopteryx grisea* as in other birds where a right ovary is occasionally developed, there is a disturbance in this uneven balance and this results in an equal distribution of germ cells to the two sides, leading to the development of the right ovary. The right oviduct however remains absent.

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21. Development of Chondrocranium in the banded Kriat, *Bungarus fasciatus*

JAGADISH PRASAD, Beawar (Rajasthan)

The Chondrocranium of *Bungarus* presents a unique and contradistinctive features unrecorded, hitherto. The enormous basal plate coalesces with the occipital region. Prominent tectum posterius and tectum Synoticum persist. The fissura metotica lies between occipital arches and auditory capsules. The fenestra 'X' invariably exists. There is a solitary pair of hypoglossal foramina. The notochord overrides basicranial fenestra. On Cochlear prominence fenestra vestibuli has been observed. Columella auris extends to quadrate. The trabeculae emerges from the basal plate. A horse-shoe band in a trabecular cartilage arise as separate entity and corresponds with the polar cartilage of Fishes, Reptiles and Birds. The cartilagenous-cum-membranous interorbital septum attribute tropotrabic nature. The Septum nasi is the further extension of interorbital septum rather than trabiculae communis. The Orbitosphenoidal cartilages are persistent. The parietotectal cartilage perpetuates with the laminae orbitonasales merging with septum nasi. The paloto-quadrate comprises quadrate and its counterpart. Meckel's cartilage bears crystalline processsus retroarticularis. Ceratophyals are rod shaped vestigial hypobranchial skeleton.

ENDOCRINOLOGY

22. Occurrence of Thyroid Follicles in the kidney of *Catla catla*.

SURENDER KUMAR AHUJA and MARY CHANDY, Delhi.

The paper deals with the sporadic occurrence of the thyroid follicles in the kidnney of *Calla catla*. They are present not only in the head kidney but in the rest of the mesonephros as well.

The distribution of the follicles is scarce and scattered. Their size and shape are also quite variable. They are smoothly spherical or ovoidal and some being irregular in cross section. The largest follicles measure about 46×42 microns and the smaller one 19×16 microns. The follicles are complete and there is no communication amongst them.

The lumen of the follicles contains the homogeneous eosinophilic staining colloid material. The follicular epithelium consists of delicately built flat cells. The nucleus is narrowly elongated and does not take a very bright stain. The distribution of the cells encapsulating the follicle is rather sparse.

The number of the thyroid follicles is gradually decreased in the posterior part of the kidney, though the size range almost remains the same.

23. Histological and Histochemical studies of the Suprarenal Cortex in Experimentally Hypothyroidised Pigeons.

TAPAN KUMAR BHATTACHARYYA and ASOK GHOSH, Calcutta.

The experimental alterations of the suprarenal cortex in juvenile pigeons following treatment with Methyl-thiouracil is described. The histological picture was supplemented by weight and planimetric studies as well as histochemical methods. A significant atrophy of the adrenocortical masses subject to thiouracil treatment was evident from histologic, histometric and weight studies. This was accompanies by medullary hypertrophy and increase in vascular areas. The atrophy of the histologically undifferentiated interrenal tissue was confined only to the

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midcortical zone. Simultaneously with cellular atrophy, there was a marked depletion of sudanophilia, cholesterol, phosphatases (acid and alkaline), ascorbic acid, nucleic acids, 'corticosteroids' and carbonyl compounds and a storage of amylase-resistant polysaccharides. Probably this atrophy is mediated through hypothalamo-hypophyseal pathway rather than by direct action of the goitrogen on the adrenal gland. The augmented output of the "G" and/or "M" factors of the TSH from the pituitary in the hypothyroidic state due to thiouracil feeding somehow causes depression in ACTH titre and a resultant adrenocortical atrophy. The histologic and histochemical findings point towards a derailment in cortical function and inhibited corticosteroidogenesis on the part of the adrenals. It is suggested that the atrophic central zone of the adrenal cortex in this avian species is regulated by ACTH titre from the pituitary. A probable participation of this zone in secreting mineralocorticoids has been pointed out and discussed.

24. The structure of adenohypophysis in the Indian fruit bat, *Pteropus giganteus*.

L. S. RAMASWAMI and T. C. ANAND KUMAR, Jodhpur.

We have been interested in the cytochemistry of the gonadotrophs in vertebrates in general. Much work has been done on this aspect in many mammals. Since it became known that the pituitary gonadotrophine are glycoproteins (mucoproteins) (Li & Evans, 1948), Purves and Griesbach (1951) used the PAS technique of Hotchkiss and Mcmanus to identify the gonadotrophs in the rat adenohypophysis. A technique for the tinctorial differentiation of PAS gonadotrophs was developed by Wilson and Ezrin (1954), and later on by Rennels (1956) and Herlant (1956). Adams (1957) was able to show the presence of two types of gonadotrophs depending on the type of PAS positive material present in them. One is labile and the other is resistant to performic acid oxidation. Basophilia in the gonadotrophs has been shown to be due to the presence of RNA (Siegal, 1955).

Nothing is known regarding the nature of the gonadotrophs of the mammals of deserts. In addition to studying these, we have also been studying the cytochemistry of the adenohypophysis of the Indian fruit bat, *Pteropus giganteus* during the various phases of reproduction. Our preliminary findings of the cell types in this bat go to show their overall resemblance to the cell types described in the bat *Myotis myotis* by Herland (1956). However, the evidence at hand enables us to identify the cell types as follows : The large angular PAS purple and Kresofuchsin positive cell as the TSH, the smaller PAS purple cells as the FSH cells and the PAS magenta cells as the LH cells.

We have also used cytochemical techniques developed in recent years with the hope of understanding more about the physiology of the gonadotrophs of the fruit bat during the various phases of reproduction.

25. Seasonal changes in the Thymus and Spleen in relation to the activity of the testes in the Lizard, *Calotes versicolor* (Daud.).

H. B. DEVARAJ SARKAR and M. APPASWAMY RAO, Mysore.

The changes in the thymus and spleen exhibit many unique features. Up to the age of puberty, they grow in relation to the growth of the body, but later their changes depend on the sexual activity. Therefore it was felt that a detailed study of the thymus, spleen and gonads in animals exhibiting sexual periodicity may throw some light on their inter-relationships. *Calotes versicolor* was chosen for this study as it exhibits definite periodicity in its sex cycle.

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The breeding season in this lizard extends from May to August and the nonbreeding season runs from September to April. During reproductive phase, the testes are large, with full of sperms (testes weight 524·87 ± 34·99). In the first half of the nonbreeding season (September to December) the testes regress completely (testes weight 39·77 ± 5·5). The tunica albuginia is thick and the seminiferous tubules are lined by highly vacuolated degenerating seminiferous epithelium with exfoliated cells in their lumen. The regressed testses regenerate in the second half of the nonbreeding season (January to April) when they increase in size (testes weight 189·66 ± 25·17) and the seminiferous epithelium proliferates showing increased mitotic and meiotic activities.

Gravimetric and histological changes of the thymus and spleen indicate an intimate relationship with the activity of the testes. At the onset of the breeding season, when there is formation and liberation of sperms in the testes, the involution of the thymus and spleen is initiated. It is suggested that the luteal hormone of the pituitary which stimulates the formation and release of the sperms in the testes, may initiate involution of the thymus and spleen. In the middle of the breeding season (June) when the interstitial cells of the testes are large, the thymus and spleen undergo acute involution. They are reduced in size (Thymus wt. 16·11 ± 0·85, Spleen wt. 16·64 ± 2·31) having degenerating plasmodial masses. This may be due to increased activity of testes and adrenals during this period. In the period of regression, when the testes are inactive the thymus and spleen remain in an involuted condition without any appreciable change in their size (Thymus 10·11 ± 0·10, Spleen 11·94 ± 1·73). However, during the period of regeneration, the thymus and spleen hypertrophy when the regressed testes shows proliferation of the seminiferous epithelium. At the end of this period (April) the thymus and spleen are large and well developed (Thymus 24·47 ± 1·69, Spleen 26·01 ± 3·39), with many thymic unicellular Hassall's corpuscles. It is suggested that the follicle-stimulating hormone of the pituitary which stimulates the seminiferous epithelium of the testes to proliferate, may also cause the regeneration of the thymus and spleen in this lizard.

26. On the extra-pharyngeal disposition of the thyroid follicles in the teleost.

A. G. SATHYANESAN and MISHRI PRASAD, Varanasi.

In the majority of teleosts the thyroid gland is in the form of scattered follicles in the subpharyngeal region among the loose connective tissue in relation to the ventral aorta. Two specimens of *Barbus conchonius* collected from Banaras during August 1961 exhibited thyroid follicles in their kidney. In one there are comparatively fewer follicles scattered throughout the kidney tissue. But in the other such follicles are numerous and their distribution is more restricted to the head kidney. However, few of them were seen sparsely located throughout the kidney, even in the posterior region. All the thyroid follicles were distended with colloid and though enlarged the smaller ones appear to be 'normal'. This problem is being under further investigation.

27. Plumage control in White-throated Munia *(Uroloncha malabarica)*.

R. N. SAXENA and P. D. TEWARY, Varanasi.

Plumage in birds can be under the control of various factors, e.g. hormones, produced by either adenohypophysis, gonad or thyroid or it may be under the

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control of genetic factors. The White-throated Munia (fam. Ploceidae) is a small bird where sexes are alike, th upper plumage is earthy brown, the upper tail coverts white and the ventral plumage buffy white. The mechanism that controls pigmentation of the plumage in this species has now been studied.

Some adult birds of both sexes were castrated and their feathers studied every month along with the plumage of some normal control birds. The castrated and normal adult males and females always regenerated similar type of plumage throughout the year. The absence of nuptial or eclipse plumage suggests that the plumage colour is independent of the gonad or gonadal hormones, and the possibility of adenohypophyseal control also seems to be out of question, as during eclipse, when the pituitary is inactive and does not produce any gonadotrophins, the bird regenerates the same plumage as in nuptial period when the pituitary produces all the hormones. It seems, therefore, that the plumage in white-throated Munia (*Uroloncha malabarica*) is free from the control of gonads and adenophypophysis and their hormones and probably is fixed by the genetic factors present in gene complex of the species.

28. On the thyroid gland of the genus *Notopterus* (Lacepede).

MADHU SUDAN SHARMA, Delhi.

In the genus *Notopterus,* the thyroid is a well developed, bilobed compact structure lying under the basibranchials. Owing to the extreme lateral compression of the body, the floor of the pharynx is narrow. Consequently, the thyroid gland is confined to the space between the first and second afferent branchial vessels and does not extend anteroposteriorly. The structure presents all the histological features of thyroid—follicles interspersed with thyroid epithelium and connective tissue. The identification of this structure as thyroid has not been reported so far, although it has been described as a sinusoid organ by earlier worker.

29. Seasonal variation in the 'Periodic acid Schiff' positive cells in the pituitary of some Catfishes.

THAKUR PRASAD SINGH and A. G. SATHYANESAN, Varanasi.

The histology of the pituitary of *Mystus vittatus* and *Clarias batrachus* is studied. Of all the components the middle glandular region of adenohypophysis exhibits seasonal variation which are correlated with the gonadial cycles. The histochemical techniques reveal that quantitative and qualitative seasonal changes are convincing in the cyanophils of the above region. Those cyanophils that are stained green or blue by modified trichrome and Mallory's triple stain are PAS positive and take up deep purple colour, while all the other cell types are PAS negative. The PAS positive cyanophils are fewer in number during the prespawning and maturing phases of the gonads. But they form the predominant cell type with granules of varying shape and size during the mature phase. And once again they lose their predominance towards the end of the spawning phase.

During the mature phase, in the middle glandular region of *M. vittatus* two types of acidophils are discernible in the Masson's trichrome stained preparations. They are the intense red Fuchsin Ponceau cells and orange-G cells. These acidophils are also PAS negative. Further work is in progress.

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30. Cytochemical study of the Suprarenal Cortex of the pigeon in electrolytic disbalance.

DILIP SINHA and ASOK GHOSH, Calcutta.

Some cytological and cytochemical effects were observed in the adrenal cortex of the pigeon treated with NaCl, KCl and desoxycorticosterone acetate (DCA). As judged by the concentration of alkaline phosphatase and cytological alterations in the midcortical zone of either NaCl or DCA treated birds, it was pointed out this this zone attained a marked atrophic condition. A hypertrophy of this zone to a moderate extent was noted in KCl overdosaged pigeons. It seemed to be obvious that these changes were brought about by an altered Na/K ratio. This suggests a probable participation of midcortical zone in elaboration of 'salt regulating hormones'. However, this hypothesis fails to explain the behaviour of cortical lipids in salt and DCA administered pigeons. The problem of differential response of lipids in our experimental materials has been discussed in the light of a probable adenohypophyseal mechanism controlling adrenocortical lipogenesis.

31. Effect of Thyroxine on Radioiodine Metabolism by the Thyroid Gland of Goldfish, *Carassius auratus*, in fresh and iodine-enriched water.

P. N. SRIVASTAVA, Jodhpur.

Two groups of goldfish, *Carassius auratus* L., were maintained in fresh and iodine-enriched water (60 p.p.m. KI solution) in a constant temperature room at 20°C. for a week. Each fish was then injected with 40 μc carrier-free I^{131}. After 24 hours, the fish in the above groups were sub-divided into two sets, in one of which the fish were injected with 0·4 ml. of 0·1% *l*-thyroxine and in the other with 0·4 ml. of physiological saline which served as controls.

The ratio between the peak values of radioiodine accumulation between physiological saline injected and thyroxine injected is approximately 1 : 3 in iodine-enriched water and 1 : 4 in fresh water. The peak value of thyroxine injected fish in iodine-enriched water is similar to the peak value of physiological saline injected fish in fresh water. Of the values at 144 hours, thyroxine-injected fish retain 9 times more radioiodine than the control, whereas in fresh water, the difference is only 5·5 times. The results suggest that thyroxine inhibits the release of radioiodine from the thyroid.

32. Effect of Thyroid Hormone, Anti-thyroid Drug and Pituitary Extract on Radiophosphorous Metabolism in Thiourea and Radioiodine treated Goldfish, *Carassius auratus* L.

P. N. SRIVASTAVA, Jodhpur.

Goldfish, *Carassius auratus* L., were treated with radioiodine and thiourea. In the former the thyroid follicles were completely destroyed and in the latter they had become hypertrophied and hyperplastic and were devoid of colloid. When they were kept in aquaria with radiophosphorous, their uptake was almost similar to one another and was half of that of the controls.

The uptake of thiourea-treated fish was increased by 40% after acetone-dried goldfish pituitary gland injections whereas in radioiodine treated fish there was no significant change.

Radioiodine-treated fish, when injected with thyroxine increased their uptake by 50% but even then was less than that of the control. When thiourea-treated

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fish were injected with thyroxine their uptake was restored to the level of that of controls.

The conclusion drawn from the present investigations is that in fishes which lack a parathyroid, the thyroid gland plays a major role in the regulation of phosphorous metabolism.

33. Castration in the male Garden-lizard *(Calotes versicolor)*.

J. P. THAPLIYAL, Varanasi.

Accessory and secondary sex characters in lizards, follow closely testicular cycle. This relationship has been studied experimentally in the male garden-lizard (*Calotes versicolor*). A number of adult garden-lizard males were castrated during early progressive phase of their sexual cycle. A group of normal males of similar body weight and gonad size were maintained as controls. The experimental and the control animals were sacrificed during the peak of their cycle. On examination, it was observed that castration leads to reduction in hemi-penes size. Vas deferens and the renal sex segments of the kidney, which were slightly hypertropic at the time castration also regress to the quiescent phase condition.

The hemi-penes of the control animals during the period increased in size, the vas deferens became greatly convoluted and tubules of the renal sex segment of the kidney showed marked secretory hypertrophy.

It, therefore, appears that in this species, for the development and maintenance of the renal sex segment, hemi-penes and male ducts during reproductive phase continued presence of testis is essential and that castration, even if performed during early progressive phase when these organs have partly developed and are further developing will lead to immediate regression of these accessory and secondary sex organs to the non-breeding condition.

ENTOMOLOGY

34. Male Reproductive organs of *Platypleura capitata* (Oliv.) (Cicadidae-Homoptera).

P. V. ANANTHAKRISHNAN, Varanasi.

Each of the paired testes in *Platypleura capitata* (Oliv.) comprises of forty-eight free follicles each of which is related to the vas deferens by means of a vas efferens. Posterior to the insertion of a pair of mesadene accessory glands the vasa deferentia ran caudad to meet the ejaculatory duct which is thick and muscular proximally and tapering distally. Each testicular follicle is covered by an epithelial sheath lacking cellular definition and is filled with mature spermatozoa and granular particles. A vesicula seminalis is absent. The proximal part of the ejaculatory duct has a thick covering of an outer coat of longitudinal muscle fibres and an inner band of circular muscles On the ventral side it bears a diverticulum pressed against the circular muscles. The chitinous intimed of the ejaculatory duct is quite prominent in the basal portion but is reduced to a rim-like lining in the distal part.

35. Internal Reproductive Organs of some Membracidae (Homoptera-Hemiptera).

P. V. ANANTHAKRISHNAN, Varanasi.

The morphology and histology of the male and female reproductive organs of *Oxyrachis tarandus* (Walk.), *Pogon bostigmatus* (Dist.), *Leptocentrus orbitus*

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(Dist.) and *Telengana consobrina* (Latr.) are described and illustrated with drawings and microphotographs. A measurable degree of uniformity in the organisational pattern of the male and female reproductive systems in Membracdiae is observed. In the males, each of the paired testes consists of a varying number (8 to 12) of free follicles which are related to the vas deferens by means of short vasa efferentia. The vas deferens in its course is dilated into a short vesicula seminalis posterior to which it receives a mesadene accessory gland. The ejaculatory duct is short and bulbous at the base and tapering towards the distal end. Inside the testicular follicles the germ cells are present in various stages of development in different sections of the follicle giving an appearance of zonation in them. The vas deferens has an outer covering of a few slips of circular muscle fibres, inside which the epithelium bounding the lumen is very thin and without clear cellular differentiation even though nuclei are discernible. The ejaculatory duct has a thick covering of circular muscles and a chitinous intima lining the lumen. The female reproductive system consists of a pair of ovaries, a pair of lateral oviducts, a median common oviduct, a pair of colleterial glands opening into the vagina, and a median long accessory gland also opening into the vagina. Each ovary consists of a varying number (8 to 12) of acrotrophic ovarioles. The proximal part of the median accessory gland is histologically different from the distal part in having a thick coat of circular muscles, a thick intima, and a small lumen; in the distal part the epithelium is made of columnar cells which are vacuolated and charged with secretion, and a muscular covering is absent. The spermatheca is simple in design and structure.

36. Phylogeny of the Auchenorhynchous Homoptera.

P. V. ANANTHAKRISHNAN, Varanasi.

In this paper, the phylogeny of the Auchenorhynchous Homoptera is discussed in the light of the results secured from a study of the morphology and histology of the internal reproductive organs. Due attention has been paid to the works of Dumeril (1806), Osborn (1895), Kirkaldy (1906, 1910), Handlirsh (1908), Taylor (1918), Tillyard (1919), Singh Pruthi (1925), Carpenter (1931), Spooner (1938), Evans (1941, 1946, 1948, 1957) and Kramer (1950). The male and female reproductive systems of Jassidae bear a stronger resemblance to the condition found in the Cercopidae and Membracidae. These three families, therefore, seem to stand together. The male and female reproductive systems of Cicadidae differ from those of Jassidae-Cercopidae-Membracidae and Fulgoroidea to a marked degree. In the female cicada the presence of a bursa copulatrix, not found in the jassoid complex, is a special feature. Further, the close association of the bursa, posterior part of the common oviduct and the stalk of the spermatheca within a common muscular covering mark the female reproductive system of the cicada as unique among the auchenorhynchous Homoptera. The male genital system of the cicada approximates to that of the jassoid group in certain minor details. But the structure of the testicular follicles, long vasa deferentia devoid of vesiculae seminales and the ejaculatory duct provided with thick longitudinal muscles outside a band of circular muscles are characteristic of the cicada and distinguish them from the other families with which we are dealing here. The Fulgoroidea stand apart from the rest of the Auchenorhyncha and even a casual study of the reproductive systems accords a separate position to this group. There is variation *inter se* in the pattern of both the system in Fulgoroidea. The male reproductive system of these Homoptera is characterised by elongated testicular follicles and a common muscular covering of the vasa deferentia beyond the seminal vesicles; and the female reproductive system is unique by reason of the structure of the complex spermatheca, fingershaped glands on the lateral oviduct, a spacious bursa opening into the sac-like gynan-

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trium, and the digitiform head of the spermatheca. Thus three lines of evolution may be traced in the Auchenorhynchous Homoptera. Cercopidae, Jassidae and Membracidae may be embraced by a single group, the jassoid complex indicating one line of evolution. Cicadidae form the second line. The Fulgoroidea constitute the third line. Illustrative diagrams of the male and female reproductive systems of the five families and two phylogenetic charts are included in the paper.

37. Morphology of the Alimentary Canal and Salivary Glands of *Tessaratoma javanica*, Thunb. (Hemiptera : Pentatomidae).

KARTIK CHANDRA BOSE and AJIT KUMAR SEN, Ranchi.

Tessaratoma javanica, Thunb. is a serious pest of the young shoots and fruits of *Lichi chinensis* (Fam : Sapindacae) one of the important fruit trees of India. The present paper deals with the morphology of the digestive system and salivary gland system of the aforesaid insect.

The study of the digestive system and the salivary gland system in the above mentioned insect reveals the following facts.

The mouthparts show no diversity from the usual Hemipteran type. The mouth is a narrow tubular part situated at the tip of the head. It leads to the pharyngeal pump, which is encased in a heavily chitinised V' shaped part inside the head cavity. The pharyngeal pump is attached from all sides to the inner wall of the 'V' shaped chitinised part by strong sets of muscles, which also operate the pump.

The pharynx in both nymphs and adults is extremely modified to form the pharyngeal pump.

The oesophagus in the first instar nymph is short and more or less translucent but in the adult it is slightly longer and shows a somewhat wide region at about the middle, which is supposed to be the reminiscence of the crop in other insects. The oesophagus joins the mid-gut by invaginating into it. There is no externally visible valve at this region.

The mid-gut owing to the diversity of external structure and probably functionally too, has been divided into four distinctly different regions e.g. the mid-gut I, II, III and IV respectively.

In the case of the first instar nymph, dissected just after the emergence from the egg, it is seen that the mid-gut-I is very large and is filled up with a green coloured liquid food which is probably the embryonic food. The mid-gut II is an imperfectly rounded whitish structure, and the mid-gut III is not well formed. The mid-gut IV is a whitish, coiled tube of uniform diameter. In adults, however, the four divisions of the mid-gut are distinct. The mid-gut-I is a brownish convoluted structure, wide at the anterior and tapering at the posterior end, finally forming a narrow, whitish 'S' shaped tube, which connects the mid-gut I & II. The mid-gut II is a rounded structure closely attached to the posterior end of the mid-gut I. It is filled up with a pasty food matter. The mid-gut III is a bright orange coloured 'U' shaped tube, which is placed normally in a horizontal fashion. Both the ends of this part are tapering. The posterior end of the mid-gut III does not form any specialised connecting tube to connect the mid-gut III with IV. The mid-gut IV is a long, coiled tube of whitish colour and uniform diameter. It joins posteriorly with the hind-gut antero-medially.

The hind gut in both nymphs and adults has been divided into two parts namely Anterior rectum and Posterior rectum. The anterior rectum consists of a more or less transparent saccular structure the rectal sac with two postero-lateral rectal pouches. There are four Malpighian tubules starting laterally from the anterior rectum slightly above the rectal pouches. In the first instar nymph the Malpighian tubules are not very much coiled.

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The posterior rectum is a short wide transparent tube starting postero-medially from the anterior rectum. Posteriorly it meets the anal region which is a well musculated bulbous structure covered externally by hard chitin. The anal opening is transverse.

There is only one pair of salivary gland situated one on either side of the oesophagus. They are tubular in structure and the tubules are coiled in a zigzag fashion. Anteriorly each gland gives off one pair of ducts, one of which from each gland goes straight forward, separately, to open at the base of the salivary chamber in the salivary syringe. The other duct which is blind, coils up in the same way as the gland itself and remains in close association with the salivary gland. There is no salivary receptacle, probably this blind coiled duct serves as a tubular salivary receptacle.

38. Studies on the Odoriferous Gland in Pentatomid Bugs. (Heteroptera : Hemiptera). Part I. *Tessaratoma javanica*, Thunb.

K. C. BOSE, G. P. TULSYAN and P. B. SINHA, Ranchi.

The present knowledge of the structure, development and functions of odoriferous glands in Pentatomid bugs is meagre and unfortunately it has been erroneously named by various workers due to misinterpretation of its functions.

In *Tessaratoma javanica*, a pest on 'Lichi' (*Lichi chinensis*—Fam. Sapindacae) and 'Kusum' (*Schliechera-oleosa*) trees. The odoriferous glands in the nymphal and adult stages present a good deal of disparity as regards their structure number and position. The functions, however, remain the same. Thus in all the nymphal stages right from the first there is a pair of these glands suspended from the abdominal tergum by means of their ducts and lying dorsal to the alimentary canal. Each duct opens to the exterior by means of a pair of openings situated on either side of the mid-dorsal line. There are two more pairs of rudimentary openings, respectively called as the first and the fourth pair. The present authors could not find any gland corresponding to these openings as reported by earlier workers. Each gland gives a bulbous appearance and can be easily divided into a thin walled anterior and thick walled posterior portion. The posterior part is thrown into foldings richly supplied with trachea and closely invested with Malpighian tubules.

Histological studies of the nymphal odoriferous gland suggest that the wall of the gland is always single layered. The posterior thicker and more convoluted wall consists of a single layer of long uni-nucleated secretory cells with a thin external layer of basement membrane and an equally thin layer of wavy intima. The anterior portion which is more smooth and thinner consists of comparatively smaller cells square or rectangular in shape and multinucleated. The nuclei are evenly distributed. The cell-walls are indistinguishable in some portions.

In the adult insect the paired nymphal abdominal gland atrophies and a single meta-thoracic gland develops *de novo*. The rudimentary tergal glands of the nymph are also present in their corresponding positions. The gland proper is a double walled sac like structure and lies in a cavity bounded by a chitinous framework. The gland opens into a pair of lateral ducts which in turn open on the suture between the meso and meta-thoracic sterna by a pair of openings, one on either side of the mid-ventral line.

In transverse sections the internal wall of the gland shows a single layer of cells with large round nuclei. The cells in some portions are aggregated and have lost their cellwalls. Prominent dark brown bodies are also clearly seen in the cytoplasm under high magnifications. The dark staining chromatin granules which are so characteristic of other glandular structures are completely lacking from these

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odoriferous glands. The layer of cell is bounded externally by a layer of basement membrane and internally by a thinner layer of very wavy intima.

The obnoxious secretion of these glands is whitish yellow in colour and oily in nature. The odour is pungent; action sightly acidic and corrosive to the skin.

The gland has been termed as 'stink gland' by Muir (1907) and 'scent gland' by Drake (1960). Imms, however, terms them as 'meta-thoracic odoriferous gland'. The present authors agree with Imms' nomenclature on grounds of the position and functions of the gland. The possibility of its use in any sexual behaviour is completely ruled out firstly as it appears right from the first nymphal instar where there is no trace of the gonads, and secondly the odour of the fluid is the same in both the sexes. Hence it can not be called a homologous structure to the scent gland of Lepidopterans. The position, mechanism of functioning and the nature of fluid of these glands is entirely different from those of the stink gland of Hymenopterans and hence this nomenclature is not applicable. The arrangement of cells in villus form, presence of dark brown bodies and the absence of dark staining chromatin granules are entirely new things for glandular structures.

39. Anatomy of the Reproductive Organs in *Dysdercus konenigii* (Fabri.).

N. B. CHATTERJEE (Shyamsundar), A. K. BASU, D. N. RAYCHAUDHURI, Calcutta.

The female reproductive system consists of a pair of ovaries extending ventrolaterally from the metathorax to the sixth abdominal segments on either side each consisting of seven acrotrophic ovarioles not in one plane, a pair of oviducts, a common oviduct, a median accessory gland, and spermatheca. Each ovariole consists of a terminal filament, germarium, vitellarium and pedicel. The two tissues of greatest interest were trophocytes of the germarium and the follicular epithelium. Histologically three zones of the germarium could be recognised. All stages of differentiation of the follicular epithelium could be found in a single ovariole. The formation of the follicular plug and corpus luteum could also be detected.

The male reproductive system is comprised of a pair of testes situated in the fifth abdominal segment on either side each consisting of seven follicles not in one plane, a pair of vasa deferentia, the proximal part of which forms the seminal vesicle while the distal part passes through a glandular structure, the mesadenes, the common vas deferens and an erection fluid chamber containing inside it an accessory gland and an ejaculatory duct. In connection with male reproductive organs interest was mainly focussed on the histology of testis. Four different zones i.e. germarium, spermatogonia, spermatocyte and spermatid could be differentiated. No apical cell could be detected.

Anatomical positions and histology of the different parts, besides those mentioned above, have also been dealt with in detail in the paper.

40. Spiracular System of *Aspongopus obscurns*.

B. S. CHAUHAN, Gorakhpur.

There are 9 spiracles present in females and 8 spiracles present in males. Two of which are thoracic and rest abdominal. First thoracic spiracle is situated on the membrane between pro- and mesothorax and second thoracic spircale is present between meso- and metathorax. The abdominal spiracles differ from the thoracic spiracles in having a prominent process, the manubrium and in the absence of opercula. The thoracic spiracle open while the abdominal spiracle close by their own elasticity. Thoracic spiracles are closed with the help of dilator

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muscles which arise on the peritreme and its contraction brings convex opercula closer and closes the opening. Hairs are present on the opening which help in guarding the foreign materials. Abdominal spiracles have an outer chamber the atrium in which lies the stigmal opening and inner chamber the trachaeal sac from which arise tracheae. Dilator muscles are attached on manubrium which help in closing the spiracles.

41. Tracheal System of *Aspongopus obscurus*.

B. S. CHAUHAN, Gorakhpur.

There are 8 spiracles in male and 9 spiracles in female two of which are thoracic and rest abdominal. From each spiracle tracheae were given out. First and second thoracic spiracles open into the air sacs which give out tracheal branches and air sacs. First spiracles sends out following main branches. One posterior dorsal, one outer dorsal, two anterior ventral, one median mesal, and one ventral posterior. Second spiracles gives following branches. One anterior dorsal, one outer dorsal, one transverse mesal, two anterior ventral, one ventral posterior. Each abdominal spiracles sends out three main branches, dorsal, mesal and ventral. Dorsal branch divides into two, the anterior one unites with posterior one of the preceding segment while the posterior branch meets the anterior one of the following segments which results in formation of dorsal longitudinal trunk on either side and numerous air sacs are given out from the tracheal branches.

42. Siphunculus and associated structure of Aphis nerii Boyer.

B. CHOWDHURY and D. N. ROY CHOUDHURY, Calcutta.

Aphis perii Boyer colonizes Calotropis species. Both alatae and apterae are provided with a pair of chitinous processes from the dorso lateral aspect of the 5th abdominal segment known as 'siphunuclus'. Through the siphunculi comes out a secretion "honey dew".

In sections a siphunculus is noticed to be made up a heavy chitinous layer outside and a muscle layer inside. The muscles of the two sides form the boundaries of a canal inside. The chitinous and the muscle layers of both sides are pushed inwards to form a valve like structure at the origin of the siphunculus from the body. Near this structure and within the body of the insect are observed large vacuolated mononuclear cells. These cells are perhaps responsible for the secretion of the honey dew and the valve of the siphunculus is perhaps for regulating the flow of the secretion.

The chemical nature of the secretion is under investigation but the presence of a volatile substance can not be doubted because of the quick hardening of the secreted material in contact with atmospheric air.

43. A note on the relative efficiency of various Parasites of Jute stem Girdler under the natural conditions.

N. DUTT, Barrackpore.

Neocatolaccus nupserhae Dutt & Ferr.; *Norbanus acuminatus* Dutt & Ferr.; *Ipobracon* sp., *Spathius* sp., *Goryphus* sp. have been recorded as the larval and pupal parasites of jute stem girdler, *Nupserha bicolor postbrunnea* Dutt. Of these, *N. nupserhae* and *N. acuminatus* are the most efficient parasites and these two together account for maximum parasitisation during the jute season in 1953-54. Parasitisa-

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tion occurs between the months of July and October, the peak period being in the month of August when nearly 22 per cent parasitisation was done by them. A survey of parasitisation carried out during this peak period, namely the month of August, 1961, indicated that *N. nupserhae* accounted for 11·90 per cent, *N. acuminatus* for 9·11 per cent and others for 2·02 per cent parasitisation.

N. nupserhae and *N. acuminatus*, thus, appear to be of greater economic importance than others. Males are unknown in *N. acuminatus* and the ratio between the females of *N. nupserhae* and *N. acuminatus* has been found to be 1 :0·4. Sex ratio between females and males of *N. nupserhae* has been recorded to be 1 :0·38.

44. Observations on the mouth-parts of Cybister Tripunctatus Asiaticus Sharp (Dytiscidae, Coleoptera).

S. C. GOEL, Saharanpur.

Snodgras (1932, '50), Imms (1939) and Dorsey (1943) described the organs of feeding in Coleoptera. The description and structure of the mouth-parts in Dytiscidae are found in the works of Sharp (1882), Bordas (1901) and Korschelt (1924). The head-capsule in Cybister includes paired antennae, mandibles, maxillae and a single labium. The last three are collectively known as mouth-parts. *Antenna* :— is a filiform, eleven jointed structure, tapering base to apex, with sensory pubescence pits in each segment, situated in front of the head lying lateral below the eyes. The scape is large and broad while the pedicle is shorter and followed by the nine joined flagellum without any setae. *Labrum* :— is a single, broad, flat sclerite, deeply notched at the anterior margin, with numerous sensory bristles arising from the sensory pits at the anteroventral margin. Posteriorly it bears two chitinous structures. *Mandible* :—adapted for biting and chewing the flesh, is more or less triangular, convex laterally while inner margin bears many stout teeth along with sensory bristles. Each mandible is a solid compact piece articulating in the concavity of the head known as ginglymus. *Maxilla* :—is with distinct sclerites as cardo, stipes, palpifer, galea, lacinia and maxillary palp. The cardo is a proximal piece articulating with cranium by means of basal condyle; stipes in a triangular piece articulating with cardo and palpifer bearing galea and lacinia on the outer hand. The palpifer have four segmented maxillary palp. The lacinia is lobelike armed with numerous sensory bristles at the distal border and well chitinized teeth at the tip. Galea is simple, tubular, two segmented and without any teeth or spine. *Labium* :—is a single, bilateral structure with two sclerite at the proximal end, gulamentum followed by mentum. Anterior to the mentum is the prementum in the form of small sclerite and bears a pair of palpiger. The ligula is formed by the fusion of glossa and paraglossa and anteriorly armed with sensory bristles, lodged in their pits dorsally. Ventral to the ligula is a pair of three segmented labial palp. The mouth-parts are prognathous and well adapted for the carnivorous habits of the beetle.

45. Observations on the head-capsule of Cybister Tripunctatus Asiaticus Sharp (Dytiscidae, Coleoptera).

S. C. GOEL, Saharanpur.

Stickney (1923), Snodgrass (1932, '35, '47), Ferris (1942) and Imms (1957) described the insect cranium and cranial sutures in a number of beetles. The paper includes the description of the head-capsule of Cybister tripunctatus, which is a chitinized, more or less oval structure. The dorsal surface of the head is known as epicranium which is a single sclerite extending from the foramen magnum

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to clypeo-frontal suture and laterally hanging over the eyes. The Y-shaped epicranial suture, variable in different insects (Snodgrass 1947), is not well developed and divides epicranium into two lateral epicranial plates. The frons extends laterally upto the eyes and is unpaired upper facial part of the head. The clypeus, anterior to the frons is separated by means of clypeo-frontal suture from each other. The labium is a well pronounced, movable sclerite articulated with the clypeus by means of clypeo-labral suture. The paired, large and bulging eyes are situated at the dorsolateral wall of the cranium without any ocelli in between the eyes. The head is ventrally supported by means of gula, extending from the post-occipital rim of the foramen magnum to the labium anteriorly. The two lateral sides are genae. The genae at their sides bear paired maxillae, antennae and mandibles. The gula and submentum are fused into a single plate termed as gulamentum. The head-capsule of Cybister has developed the fusion of sclerites.

46. Structrue of the Ovipositor in *Anisops bouvieri* Kirk. (Heteroptera : Notonectidae).

A. K. GORAI, Midnapore.

Anisops bouvieri is found abundantly in the fresh waters of Midnapore district of West Bengal. In female the abdomen is ten segmented, the first one is reduced, the ninth forms the genital armature and the tenth the anal siphon.

The ovipositor consists of two pairs of valvifers and three pairs of valvulae. The first pair of valvifers are triangular plates attached to the sides of the eighth tergum. The second pair is placed inner to the first and forms a sort of an arch dorsally. The ninth tergum is modified to form the second valvifer.

The first pair of valvulae are elongated plates serrated along their inner margins. These are attached to the second pair of valvifers by ligament. The second and third pairs of valvulae are short processes arising from the second pair of valvifers.

The eggs are deposited into the holes on the stem and leaf peduncle of Myrmeophyllum heterophylla, dug by the ovipositor. The first pair of valvulae together rub against the stem or leaf-peduncle and thus a hole is produced in the plant. The mature eggs are slipped through these holes and deposited inside for further development.

Several muscles are associated with the ovipositor for the movement of different parts.

Details will be published elsewhere.

47. Study on Gall Midge (Itonididae : Cecidomydae-Diptera-Nematocera) from India.

P. GROVER, Allahabad.

Subfamily *HETEROPEZINAE*

Meinertomyia ovalis, sp. nov.

A new species of the genus *Meinertomyia* Felt has been described in the present paper. The diagnostic features of the species are.—eyes confluent above; palpi triarticulate; antenna with 14 segments, shorter than the length of body, third and fourth antennal segments not fused and unequal; vein *Cu* simple and faint; legs long, with five tarsal segments, metatarsus shorter than the second tarsal segment; claw simple and strongly bent; empodium longer than the claw; ovipositor with one dorsal broadly oval and two elongated oval ventral lamellae.

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It differs from the known species by the above mentioned characters.

Meinertomyia Felt is one of the very old genera having been erected in the year 1911 with *M. faciata* Felt as the type. Mani in 1934 recorded this genus for the first time from old world and described *M. aequipalpis*. *M. inaequipalpis* a second species was described by the same author three years later. Third species *M. manii* was described by Rao in 1949. The present species is the fourth to be described from the oriental region.

48. Taxonomy, Zoogeography and Evolution of the Indo-Australian species of the Genus Theronia (Hymenoptera).

V. K. GUPTA, Michigan.

49. The Blood Vascular System of *Labidura riparia*, Pallas, Var. *inermis*, Brunner.

KUSUMAVATI KADAM, Jabalpur.

The blood vascular system of *Labidura riparia*, Pall., Var. *inermis*, has been studied in detail. It does not consist of closed distributing and collecting vessels. The blood flows freely through definite chambers formed by means of diaphragm. There are in all three longitudinal chambers; dorsal or pericardial, perineural and median or perivisceral. The main blood propelling organ is the dorsal vessel. The blood has no haemoglobin and hence do not supply oxygen to the tissues.

The dorsal vessel is a long tube extending anteriorly from the ninth abdominal segment into the head. Posteriorly it is chambered and forms the heart proper. Anterior tube is the aorta. The systolic and diastolic movements are clearly seen in a freshly dissected specimen. Each chamber is dilated posteriorly and is perforated by a pair of ostia, guarded by muscular valves.

The dorsal diaphragm lies immediately below the heart and at some places margins of the diaphragm are drawn out into points. The free margin between these attachments form deep semi-circular notches through which the pericardial sinus communicates with the perivisceral sinus. The ventral diaphragm is a long muscular sheet lying above the ventral nerve cord. The free ends of the diaphragm allow communication between the perineural and perivisceral sinuses.

Blood is a colourless fluid and consists of the plasma in which float the blood corpuscles. Blood corpuscles are of four types; 1. Macronucleocytes with large nuclei, 2. micronucleocytes with small nuclei, 3. large vacuolated fat cells and 4. amoeboid cells.

The course of circulation of blood is described in detail.

50. The Secretory System of *Labidura riparia* Pallas, Var. *inermis*, Brunner.

KUSUMAVATI KADAM, Jabalpur.

The main organs of excretion are the malpighian tubules. The integument, tracheae and nephrocytes also help to some extent in the process of excretion.

The malpighian tubules are long, thread like structures attached in four groups to the posterior end of the midgut, each group consisting of 10 to 12 tubules. The base of each group is dilated to form a basal vesicle at the point of attachment with the gut. The tubules are yellowish in colour due to the presence of waste matter in them. They lie free in the body cavity and are kept in position by a network of tracheae. Slow movement of the excretory matter in the tubules is noticed in a freshly dissected specimen in normal saline, which is brought about by two or three fine longitudinal muscle fibres present in each tubule.

Histology of malpighian tubules is also studied.

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51. Digestion and Absorption of Food in *Tribolium castaneum* (Herbst.).

S. S. KRISHNA and K. N. SAXENA, Delhi.

Investigations on the digestive enzymes in the gut of larva and adult *Tribolium castaneum* (Herbst.) show that the insect possesses an amylase, a maltase, an invertase, an α-galactosidase, a β-galactosidase, a β-glucosidase, a proteinase and an esterase. The invertase of this insect is an α-*d*-glucosidase. The enzymes polypeptidase and lipase are totally wanting. All these enzymes, which differ from one another in the range of pH within which they show activity, bring about maximum hydrolysis at pH 5·5. Concentration of the enzyme invertase in the mid-gut of the insect remains more or less the same regardless of the time of its feeding and that in the hind-gut increases with the time-lapse after the meal. Different carbohydrases differ from one another in their relative concentration in the gut and they may be arranged in the following order according to their relative strength : amylase $>$ invertase $>$ β-glucosidase $>$ α-galactosidase $>$ β-galactosidase. Studies on the hydrogen-ion concentration of the gut of *T. castaneum* indicate that the pH in all the regions of the gut in both the larva and the adult is $>5{\cdot}2<6{\cdot}0$ except for a short zone in the hind part of the mid-gut of the larva where the pH is $>6{\cdot}8<7{\cdot}0$. Change in pH of the diet does not affect the pH of the gut. Observations on fate of invested food within the gut reveal that digestion of sucrose and absorption of glucose and fructose occur in the mid-gut of the insect at a fairly rapid rate so that they are completely utilised before the food-residue is passed out. Correlation between the natural source of food of the insect and its capacity to digest, absorb and utilise the available nutrients is discussed.

52. Feeding response of adult *Tribolium* to Carbohydrates in relation to their utilisation.

S. S. KRISHNA and K. N. SAXENA, Delhi.

Study of the role of certain carbohydrates in stimulating ingestion of food by adult *Tribolium castaneum* indicates that the feeding activity of the insect is greater on sucrose and fructose than on starch, maltose, glucose, raffinose, melibiose and agar agar. However, wheat flour, the natural food of the insect, elicits a significantly greater feeding response than any of these carbohydrates. Investigations on the capacity of *T. castaneum* to digest and absorb these carbohydrates show that the insect is physiologically adapted to utilise them. As regards nutritional efficiency of these carbohydrates for survival of adlult insect, starch and maltose support maximum length of life. Glucose, melibiose and lactose are comparatively less efficient in supporting adult life while the nutritional efficiency of the remaining carbohydrates namely, fructose, sucrose, melezitose, raffinose and cellobiose is very poor. Correlation among the relative proportion of different carbohydrates in the cereals, capacity of the insect to digest and absorb them and their efficiency to support its survival is discussed.

53. Post-embryonic Development of Skeleto-muscular system of thorax in *Dysdercus kœnigii* (Fabr.) (Heteroptera).

SUDARSHAN KUMARI, Delhi.

Study of changes in skeletomuscular system of thorax of *Dysdercus koenigii* during its post-embryonic development reveals that the sclerites of this region not only increase in size but also undergo a progressive differentiation. In the first instar nymph the pronotum is a single plate which, in the second instar, gets

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differentiated into three subequal sclerites. In the fifth nymphal instar the third pronotal sclerite becomes much larger than the second and approximates the condition found in the adult. The meso- and metanota of the first instar nymph also consist of a single piece each almost equal in size. In the third instar the mesonotum becomes twice as long as metanotum. The transscutal and scuto-scutellar sulci are formed only after the final moult to the adult.

Rudiments of the fore- and hindwings appear in the third nymphal instar. In the fourth instar nymph two main tracheae enter the wing pads, each divides into three and all the six tracheae later form the longitudinal veins of the adult. Development of the articular sclerites of the wings occurs during the final ecdysis of the fifth instar nymph.

Thoracic musculature of the nymph differ from that of the adult in the smaller size, lesser number and arrangement of various muscles. However, certain muscles *viz.* the second dorso-ventral muscle of the mesothorax and the ventral oblique muscles of the meso- and meta-thorax are present only in the nymphal stage and not in the adult. A number of muscles, particularly those of the wings present in the adult insect, are wanting in the early nymphal stages. Their development is closely related with that of the wings.

54. Studies on the Grasshopers of Pilani (Rajasthan).

H. L. KUNDU, A. K. DATTA GUPTA and L. M. L. MATHUR, Pilani.

Certain aspects of the external morphology, abundance in the field and habitat of *Acrotylus humbertinus* Sauss. and *Spathosternum prasiniferum* Walk. (Acrididae) have been studied. Weights of the body as well as the legs were taken and the lengths of the different parts of the body such as elytra etc. have been measured. Fifteen specimens of each sex and sixteen linear measurements on each individual's body parts were taken. Attempts were made to examine the data by computing the variance and standard error (S.E.). The ratios between the weights of the hind legs and the body were obtained.

These data were studied with a view to examining variations at both intra and inter specific levels and in certain cases significant differences amongst them noticed. A tentative explanation has been put forward to explain such differences.

Tibial spines were counted and their distribution recorded. Abundance of these grasshoppers in four different plots during the monsoon and winter of 1960 was estimated. Certain conditions of the habitats of these grasshoppers such as, soil moisture, weather and vegetation were also studied.

55. Control of the lissora fruit weevil, *Baris codiræ* Marshall (Insecta : Curculionidae), a serious pest of Rajasthan.

K. S. KUSHWAHA, J. C. SHARMA and L. S. SHARMA, Udaipur.

Kushwaha has already studied the biology, external morphology, damage and the measures of preliminary control of the lissora weevil, *Baris cordiae* Marshall (Subfamily Baririnae) infecting about 88 per cent fruits of lissora of goonda (*Cordia dichotoma* Frost. f., syn. *Cordia myxa* Roxb. and *Cordia oblique* Willd.) around Udaipur as observed since 1957. The infestation starts mostly during March and April.

Further trials to control this borer were conducted during 1960 and 1961 in different localities at Udaipur. The following insecticides were used as bloom sprays in concentrations mentioned against each : Endrin 20% EC. (0·025%, 0·05% and 0·1%), DDT 50% WP. (0·25%), BHC 50% WP. (0·25%), Folidol 46·7% EC.

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(0·025%) and Ryania 90% WP. (1%). Of these, only Endrin has statistically given highly significant results over control and other treatments in all the three concentrations (*vide supra*), whereas in other cases the results were insiguificant. Further it was noted that the three doses of Endrin were insignificant amongst themselves.

56. Relative role of Abrasive Dusts, Activated Clays and Gas Absorbing Carbon on *Tribolium castaneum* adults.

S. K. MAJUMDER and M. K. KRISHNAKUMARI, Mysore.

Acid activated clays were found to be more insecticidal than the abrasive dusts, such as carborundum, emery and glass powders. Silica gel and carbon were hygroscopic and lost insecticidal potency, while active clay, being less hygroscopic, maintained its insecticidal potency when stored in non-airtight containers. The insecticidal actions of the dusts were primarily related to the lipophilic activity and removal of lipoids from the insect cuticle. Relative humidity of the micro-climate exerted secondary action on the insect mortality. The rapidity with regard to death of the test insects depend on the relative humidity of the atmosphere and also of the micro-climate during the tests. Desiccant like $CaCl_2$, had very little insecticidal effect. Even at 53% relative humidity, the abrasive dust failed to induce mortality of test insects within 96 hours of exposure, while active clays and freshly prepared carbon were highly effective and induced mortality within 16 hours. The results of the present study indicated that, sorptive dusts kill insects by removing lipoid from the insect cuticle and not by direct desiccant action, and subjecting them to the loss of moisture. The rapidity of which depended on the degree of unsaturation with regard to the moisture in the atmosphere and not the sorptive properties of the materials.

57. The Occurrence of Spinose Ear Tick, *Otobius megnini* Duges, 1883, in Poona, Maharashtra State.

P. BALARAMA MENON, Cuttack.

This paper records the presence of the Spinose Ear Tick, *Otobius megnini* Duges (Syn : *Ornithodorus megnini*) in horses in Poona and nearby localities. This is the first record of this uncommon species of tick from this part of the country and is a new locality record for the species in India. Large numbers of the nymphal stages of the tick and a few in the larval stage were collected from inside the ears of horses both country bred as well as from a well maintained stud farm. It was believed that the Indian bred horses contract the infection from imported ones from endemic countries. But the present finding reveals the infestation as more widespread and occurring in indigenous breeds which could have had no contact with imported horses.

58. Dimetilan as a poison bait for the control of houseflies.

P. BALARAMA MENON, Cuttack.

A red coloured cartoon disc impregnated with a chemical belonging to the carbamate group, Dimetilan, as well as an attractant, produced by Geigy, Switzerland, was tested for the control of houseflies, *Musca domestica nebulo* (Fabr.). A series of experiments conducted on fed as well as starved houseflies showed that flies are attracted to the discs on which they feed without hesitation and die

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immediately after. Normal fed flies as well as those starved over night feed readily on the disc. More than 90 per cent kill was obtained. Even in the presence of milk, a large percentage of flies were attracted to the disc.

Dimetilan acts chiefly as a stomach poison and since its solubility in water is of decisive importance, the disc is to be kept moist to obtain its full effect. The disc contains, within a small surface, a relatively high concentration of active ingredient in the form of water soluble stomach poison. The toxic hazard involved in the use of this product is claimed to be practically nil.

59. Studies on the morphology of the various developmental stages in the life-history of the tea mosquito bug, *Helopeltis theivora* Waterhouse.

D. MUKERJI and RAMKRISHNA GHOSH, Calcutta.

Since the discovery of *Helopeltis theivora* from the Indian tea gardens by Waterhouse in 1886, no further description of the species has ever been attempted. The present observation chiefly deals with the description of the nymphal stages of the insect. There are five nymphal stages before the imagos are obtained from the egg. The main changes at different stadia are as follows :

1. The scutellar horn which is the characteristic of the species appears as a protruberance in the first nymphal stage, it becomes fully formed in the fifth instar.
2. Wing pads appear at the fourth instar stage.
3. The external genitalia appears at the fourth instar stage and becomes fully formed at the final instar, when the distinction between male and female insect becomes possible.
4. Wing venation of the adult insect has been described and the measurement of the various parts of the body has been taken of the different stages in the life-history of *Helopeltis*.

60. Notes on the Biology of *Epilachna vigintoctopunctata* M.

G. P. MUKERJI, Bhopal.

Epilachna vigintoctopunctata M. is fairly well distributed and quite common in different parts of India. In the breeding season it appears in good number and causes severe damage to different cucurbetaceous and solenaceous vegetables. In this paper the author has attempted to give some information regarding the life-history of the beetle.

The insect starts copulating about a week after their emergence from the pupa. Soon after copulation they start laying the eggs. The eggs are laid in batches and attached firmly to the leaves or muslin. They are delicate, light yellow, barrel-shaped having a narrow anterior end. On the 11th day eclosion takes place and the first stage larva is given out. There are four larval instars each of five to seven days duration. These grub-like, slow moving, small-sized larvae feed voraciously. The different instars are distinguished by the size and the branches of the bristles on the dorsal side which increase in every successive moult. For pupation the final instar larva attaches itself to the leaf or muslin with the dialated anus; Post. adhesive disc Mukerji (1959) and prepares for pupation. The pupa is a non-feeding obtect pupa. Antennae and the legs are soldered down to the body. In some of the pupae the final instar exuvia remains attached while in others it is only clothed in a thin, hairy pupal covering. The adult emerges from the pupa after about seven days. After few hours of emergence the adults show the normal movements, take to flight and start feeding actively. Both the sexes look alike except that the males are smaller in size.

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61. The effects of temperature and humidity on the development of different stages of *Callosobruchus maculatus* Fabr.

M. K. MUKERJI and D. N. RAY CHAUDHURI, Calcutta.

The effects of temperature (20°C 35°C) and relative humidity (45%—90%) on the developmental stages of *Callosobruchus maculatus* Fabr. were noticed. It was found that the relative humidity of different percentage at all temperatures (20°C—35°C) have no effect on the egg, larval and pupal periods. The increase of temperature (20°C—25°C—30°C—35°C) decreases in the number of days for development of the various stages.

The temperature of 20°C seems to be the optimum for the proper development of this insect as the total number of days required for total development is maximum at the temperature and which phenomenon is essential for maintenance of a race.

62. Some Parasites associated with Coccids and their possible utilisation in the biological control of Coccids.

E. S. NARAYANAN and B. R. SUBBA RAO, New Delhi.

There are very few insect pests that are immune to the attack of parasites and predators. This phenomenon is particularly emphasised in the case of coccids that are attacked by encyrtids, miscogasterids and eulophids. While eulophids and miscogasterids are casually reared from coccids, encyrtids as a rule dominate as primary parasites of coccids.

In this paper three coccids namely, *Phenacoccus* sp., *Lecanium* sp. and *Ceroplastes* sp. were reared in the laboratory from the field collected material for possible emergence of parasites. The miscogasterid *Anysis alcocki* (Ashmead) was reared from both *Ceroplastes* sp. and *Lecanium* sp. while *Ceroplastes* is a known host, *Lecanium* has been recorded as a new host in India. A species new to science *Cerapterocerus indicus* has been reared from *Lecanium* and described. Another species *Aphycus zebratulus* new to science is also described. Field observations showed that there was no multiparasitism by these two species. Natural parasitism was about forty per cent.

Aphycus zebratulus new species, comes very close to *Aphycus zebratus* Mercet but differs from it considerably. So also *Cerapterocerus inducus* new species differs very much from the two known Indian species *C. virens* Alam and Man Mohan and *C. antennatus* Narayanan. *Cheiloneurus* sp. runs very close to the described *C. pyrillae* Mani but differs from it in certain characters. Further studies are in progress.

From the brinjal mealy bug *Phenacoccus* sp., thee species of parasites were reared, namely, *Leptomastix* sp., *Cheiloneurus* sp. and *Pholidoceras* sp. It is possible that *Leptomastrix* sp. and *Cheiloneurus* sp. are new to science.

The coccids and mealy bugs have always posed as a serious problem to economic entomologists. On account of their staggering rate of reproduction and the uneconomic proposition of the chemical method of control over large areas, the biological method of control has been a success in the case of some of these pests. The discovery of these new parasitic species will give an impetus to workers on biological control to utilise them for field trials for the control of these pests.

63. Respiratory metabolism during embryogenesis of a diapause species of field cricket, *Gryllus pennsylvanicus* Burmeister (Orthoptera : Gryllidae).

R. RAKSHPAL, Lucknow.

During the embryonic development of *Gryllus pennsylvanicus* the rate of respiration continues rising until the fifth day, after which the rate falls off to about

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one-ninth on the tenth day. This value is maintained for a further period of ten days. In the post-diapause embryos the rate of oxygen consumption rises continuously throughout the entire period of development. The studies reveal that the diapause in *G. pennsylvanicus* is obligatory and that the embryos enter physiological diapause one day later than the morphological diapause and enter a complete diapause condition after a further period of five days. The post-diapause embryos take three days to reach the maximum rate of respiration of the pre-diapause period.

64. The Neurosecetory Cells in the Beetle, Heliocopris bucephalus F.

P. V. RANGNEKER and H. B. NIRMAL, Amravati.

The distribution of neurosecretory cells in the central nervous system of *Heliocopris bucephalus* F. resembles on the whole to that of fruit fly, *Chaetodacus cucurbitae* Coq. (Nayar, 1954). But in *Heliocopris bucephalus* on the basis of the structure and staining properties, it has been possible to identify three types of neurosecretory cells; and they have been designated as A, B, and C types. All the three types of cells are reprsented in the thoracic and abdominal ganglia. However in the brain, B-type is absent while the other two types are present.

The A-type of cell shows numerous small vacuoles and their number on the average is twenty in each cell. The B-type of cell possesses a single large vacuole extending over a major area of the cell. Presence of vacuoles indicates a high degree of activity on the part of neurosecretory cells; wherein there is a constant elaboration followed by quick withdrawal of neurosecretory material. In the A-type of cell the numerous small vacuoles appear to converge on the origin of axon; while in the B-type the single large vacuole extends into the axon. These observations suggest that the neurosecretory colloids formed inside the cell are transported through axon. These observations on the axonic transport of the secretory material, support the earlier findings by Scharrer (1952b) in Leucophea; Arvy, Bounhiol and Gabe (1953) in Bombax; Arvy and Gabe (1954) in Plecoptera; E. Thomson (1954) in Calliphora and M. Thomson (1954) in Hymenoptera. The C-type of cell shows complete absence of vacuoles but at the same time neurosecretory material is observed flowing into the axon of this cell. On the basis of the number, size and disposition of vacuoles present in the cell it can be surmised that the degree of activity in the B-cells is higher than that of the A-cells. Since the C-type of cells do not show any vacuoles it is suggested that its degree of activity is the lowest.

65. The anatomy of the Digestive organs of *Sphærodema rusticum* Fabr. (Heteroptera : Belostomatidae).

S. C. RASTOGI, Pilani.

Sphaerodema rusticum is a fresh water and predacious hemipteran. It feeds upon aquatic insects such as dragon-fly larvae, crustaceans, mosquito-larvae and larvae of aquatic bettles. In captivity it does not attack any organism.

The alimentary canal is divisible into three primary divisinos, viz., the foregut, midgut and the hindgut. There is no true mouth and the sucking beak is three segmented. The foregut consists of a sucking pump (pharyngeal pump) and an oesophagus. The pump is a V-shaped sclerotised trough whose roof is invaginated into the chamber to form an operculum. The operculum is provided with dilator muscles which originate from the clypeal area. The oesophagus is tubular and lined by cuboid cells. A thin layer of chitin is secreted by the cells. The oesophagus extends back into the midgut and forms the oesophageal valve.

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The midgut is differentiated into four regions. Midgut is characterised by the presence of columnar cells and absence of an intima and peritrophic membrane. Another feature of the midgut is the presence of regenerative cells enclosed in dome-shaped pockets called 'nidi'. They give rise to new epithelial cells by a process of proliferation. The epithelial cells show periodic delamination and the secretions enter the lumen by holocrine method only.

The hindgut is composed of an ileum and a rectum. A thin-walled rectal caecum arises from the rectum at the junction of the ileum and the rectum. Ileum is composed of two types of epithelia. The normal epithelium is unfolded and consists of tall cells without cell boundaries. The cytoplasm is vacuolated and perforated by tracheal openings. The other epithelium of the ileum resembles the epithelium of the rectum and the rectal caecum in all details. The caecum is a respiratory and hydrostatic organ. A well developed proctodaeal valve is present.

There are four Malpighian tubules which arise from the midgut slightly anterior to the proctodaeal valve. The salivary glands consist of a pair of principal and a pair of accessory glands. The principal glands are aciniform while the accessory glands are vesicular.

66. Observations on the life-history of Red Pumpkin Bug, *Coridius janus* Fabr. (Heteroptera : Dinidoridae).

S. C. RASTOGI and MISS KRISHNA KUMARI, Pilani.

Coridius janus Fabr. is pest on cucurbitaceous plants such as *Cucumis sativus*, *Luffa cylindrica*, *Luffa acutangula* and *Lagenaria vulgaris*. Nymphs and the adults actively feed upon the plants. Breeding in the bug commences during the rainy season i.e. from July to September and during this time they form heavy infestations on the cucurbitaceous plants. The males are smaller with brilliant orange red colour while the females are larger with dull red colour. Late evening and dark hours of the night favour copulation which lasts for 2 to 2½ hours. Eggs are laid in chains and each measures about 1·8 mm long. When freshly laid, the eggs are bluish white but later on the colour changes to reddish brown and subsequently to dark brown at the time of hatching.

The life-history of *Coridius janus* consists of five nymphal stages and is completed in 25 to 30 days. The phenomenon of moulting of each nymph is as usual, as in other bugs. First of all the skin becomes loose and gradually braeks near about the mid-dorsal region of the thorax. The head comes out first, followed by the remainder of the body. The newly moulted instar is pinkish which gradually attains its normal red colour. The process of moulting does not last more than 15 minutes. The measurements of the different parts of the body in each nymphal stage have been given in the paper. The length of the antennae shows a considerable growth in relation to each nymphal stage. Growth ratio has been shown graphically.

67. Biology of *Chrysocoris stollii* Wolff Pentatomidae (Hemiptera-Heteroptera).

A. ROY and D. N. ROY CHOUDHURY, Calcutta.

Chrysocoris stollii Wolff is a pest chiefly on various *croton* species in and around Calcutta. The insects are found almost throughout the year. But the number greatly increases after the rainy season and in autumn and the same decreases very much during summer. The number of females is always more than the number of males. The insects are found in copula more during winter than during the rest of the year. In general the insects are less frequent during mid-day when they hide themselves in suitable humid places.

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The insects feed on the plant sap either from the fruit or from the leaves or stems.

Before copulation the insects perform a sort of a courtship for about 15 to 30 minutes. Copulation starts in the afternoon and the period lasts for about 17 to 20 hours. Pre-ovipsoition period is 3 days. The pearly white eggs are laid in batches of 7 to 31 in double row.

68. Food intake in relation to the growth of *Dysdercus kœnigii* Fabr.

K. N. SAXENA, Delhi.

Observations on the fluctuation in the feeding activity of fifth instar nymph of *Dysdercus koenigii* at different stages of its growth and on the effect of food intake on the growth of the insect are presented in this paper. Feeding activity of the insect is best expressed in terms of duration of feeding per 4-hour period per individual and also on the basis of percentage of individuals showing feeding response. During the fifth nymphal instar the insect starts feeding 16 hours after the previous ecdysis and its feeding activity reaches the maxium level between 24-32 hours after the moult. Subsequently it declines till after 80 hours the insect does not feed on the cotton seed until after the next ecdysis. Its feeding activity on the cotton leaf or on water remains uniformly low and identical throughout the instar and it is significantly lesser than the feeding activity on cotton seed during the active period between 16th and 80th postmolt hours. The individuals deprived of cotton seed only during the fifth nymphal instar continue to show high feeding activity on the seed almost till their death. They fail to moult again and survive for a period twice the normal duration of the fifth nymphal instar. On the other hand, the individuals allowed to feed on cotton seed for a restricted period during each of the five nyhphal instars show high mortality of the growing nymphs. Nevertheless, the survivors complete their development to the adult stage in the same period as the nymph given continuous access to the diet.

69. A contribution to our knowledge of Noctuidae affecting cotton in Rajasthan.

B. K. SRIVASTAVA and S. P. BHATANAGAR, Jobner.

The present authors have undertaken a systematic survey of Noctuidae affecting cotton crop in Rajasthan. The paper deals with seasonal incidence, nature of damage, life-history and distribution of Noctuidae as pest of cotton in the state. These identified noctuid pests include leafworm, *Prodenia litura* F. and lesser leafworm, *Laphygma exigua* Hb. and semiloopers, *Cosmophila indica* Gn. and *Tarache nitidula* F. on leaves; and spotted bollworms, *Earias fabia* stoll. and *E. insulana* Boisd., and gram caterpillar, *Heliothis obsoleta* Hb. on growing shoots, floral buds, squares, flowers and green bolls.

70. The flexor and extensor mechanism of the wings of *Odontotermes obesus* (Rambus) (Isoptera, Termitidae).

H. S. VISHNOI, Delhi.

The paper deals with the description of the basal articular structures of the two pairs of wings of *Odontotermes obesus* (Rambur) and their movements during flexion and extension. During repose the wings are held flat along the dorsal surface of the abdomen. The extension is caused mainly due to the coxo-subalar

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muscle which depresses the subalar sclerite; incidentally, the chain of the three axillary sclerites is opened pushing laterally the anal and the median sclerites of the wing-base and hence the extension of the wings. Flexion is caused due to pleuro-alar muscle which rotates the third axillary sclerite dorso-medially on its basal pivotal articulation on the extremity of the posterior notal wing process and the third axillary thus pulls the anal sclerite of the wing base medially. During this displacement of the third axillary the second and the first axillary sclerites are also automatically rotated dorsally because of their slightly overlapping condition. On account of the hinged articulation of the first axillary with the lateral margin of the tergal plate the entire set of axillaries when rotated during the wing-flexion develops certain force of elasticity that would also contribute to reverting the wing to its extended condition when the flexor muscle is relaxed.

EXPTL. ZOOLOGY

71. Failure of organisation due to misdivision of cells in urethane treated chick embryos.

S. ADHIKARI, Calcutta.

Versatility of urethane as an extraordinary chemical which produces diverse categories of actions on the different components of a cell is rather well known. This chemical has been experimented upon developing chick embryos to intervene into organisational changes through cellular misdivision. 0·5% urethane constitutes the effective dose which has been administered into fertilised and unincubated egg-white leghorns. The end results have been scrutinised after 48 hours of incubation. The organisational set up of the treated embryos depicts a marked retardation in development. The neural tube becomes bifurcated at the anterior region, the mesodermal and endodermal derivatives fail to establish themselves. The notochord is shortened and is associated with the main axis only to some length. There is no eye cup formation and the cardiac structures are lacking altogether. Examination of ill formed tissues reveals a number of interesting changes in cell structures. The nuclei are much enlarged; cytoplasm appears granular. Often dividing cells are seen in a state of misdivision. Daughter cells cannot separate but are pulled out in opposite poles to an enormous distance. Presence of more than one nuclei is seen in large number of cells. Often mass of necrotic cells with pycnotic nuclei are observed.

72. Induction of gastric ulcers in the toad, *Bufo melanostictus* by modified Shay operation.

M. APPASWAMY RAO, Mysore.

The mechanism in the induction and formation of gastric ulcers in man is not well understood. To study the pathogenesis of their production and to find means of preventing their appearance, it becomes desirable to produce these ulcers in experimental animals. As frogs and toads are used for experimentation, the Shay operation with some modifications has been employed to induce gastric (Pyloric) ulcers in the toad, *Bufomelanostictus*.

Toads weighing 20-45 gms, kept in humidity chamber, are starved for two days. Ligation of the stomach in the pyloric (single) or esophageal-pyloric (double) region is made under ether-anaesthesia in sterile conditions. Five days after ligation, the toads are sacrificed. The incidence of animals showing ulcers is noted, severity is estimated and the number of ulcers per toad is counted. These three values are combined and expressed in terms of ulcer index.

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In the pylorus and esophageal-pylorus ligated toads, the incidence of gastric ulcers is very high when compared to those of sham operated controls. With single ligation of the stomach, the ulcer index is $14{\cdot}8 \pm 1{\cdot}1$, with double ligation, it is $13{\cdot}99 \pm 0{\cdot}96$, but in the control it is only $3{\cdot}2 \pm 0{\cdot}39$. Usually 3 to 6 ulcers are found in the pyloric (Glandular) region and very few in the cardiac portion of the stomach. Histological studies of these ulcerated stomach indicate thining of the gastric mucosa with infiltration of leucocytes. In the regions of acute ulceration the gastric epithelium and sub-mucosa disappear completely. The necrosis of the gastric mucosa and sub-mucosa is due to the inflammatory reaction of the gastric juice accumulated in the stomach after ligation. It is suggested that this technique may be employed to test the anti-ulcerogenic compounds.

73. Rate of cell contact in centrifuged amoeboid cells.

S. BANERJEE and S. MOOKERJEE, Calcutta.

The rate of reconstitution in dissociated sponge cells can experimentally be altered by subjecting them to various cyto-physiological conditions. Here is one such instance of an effect of centrifugation upon the tempo of aggregation in dissociated sponge cells. The sponge cells were dissociated by the classical technique of Wilson, by seiving them through silken mesh and then subjecting them to a force of 2000 'g' and 3000 'g' for 5, 10, and 15 minutes. The rate of reaggregation in different experiments were calculated and graphically plotted.

The highest rate of contact in dissociated cells, previously centrifuged at 2000 'g' for 5 minutes, is about ·8% higher than that of the normal. Except in this series, in all other experiments, the rate of reconstitution is lower than that of the normal. The behaviour of individual cells after centrifugation during the process of reconstitution has been discussed.

74. Effects of certain drugs on the gas contents of the swimbladder.

PADMAKAR V. DEHADRAI, Delhi.

Fange (1953) in his pharmacological studies reported the effects of various sympathicolytic and symphathicomimetic drugs on the gas secreting mechanism of *Ctenolabrus rupestris* and *Gadus collarias*. But a particular drug may not be effective in all fishes. During the present investigation, yohimbine and atropine were found to have no apparent effect on the swimbladder or its gas contents in fishes studied, while dihydroergotamine and adrenaline were found to be very effective.

Dihydroergotamine injected intramuscularly, acts as an effective sympathicolytic agent on the swimbladder of *Ophicephalus marulius, O. punctatus* and *O. striatus*, as it causes marked increase in carbon dioxide and oxygen contents of their swimbladder, while it had no effect on the swimbladder or its gas contents in *Mastacembelus armatus* and *Colisa fasciata*. Atropine showed no effect on the swimbladder or its gas contents in any fish studied.

Intramuscular injection of adrenaline in *O. marulius, O. punctatus, O. striatus* and *Mastacembelus armatus* caused a marked decrease in carbon dioxide and oxygen contents of their swimbladder. In *Colisa fasciata*, however, only oxygen content of the swimbladder was lowered by adrenaline. Increase in carbon dioxide content after adrenaline in *Colisa fasciata* is probably due to lower rate of resorption of carbon dioxide in the fish, in absence of an efficient posterior resorptive chamber

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as in *Ophicephalus* and *Mastacembelus*. The inhibitory effect of adrenaline, however, on the gas secreting mechanism in the above fishes is clearly seen.

75. Surface activity in amoeboid sponge cells under the stress of different pH.

B. GANGULY, Calcutta.

The present experiment is in anticipation to have more information about the nature of movement undergone and morphological characteristics shown by amoeboid sponge cells in various pH conditions of the suspension fluid.

In a medium of normal pH (7·1), the amoeboid sponge cells throw broad pseudopodia at the rate of 6 to 8 per minute. Each pseudopodium is formed by the participation of both cell membrane and endoplasm, and surface activity continuous up to 4 to 6 hours in isolated condition.

A shift towards acidity (pH 4 & pH 6), retards the movement and to alkalinity (pH 8·5 & pH 9·5) first accelerates the surface activity but finally stops the mobility. The acid and alkali treated cells may be brought back to normal condition after reexposure to a suitable opposite pH. Experiments dealing with the treatment by opposite pH show three different trends—either (1) cells exhibit sign of recovery, or (2) cells continue to show effects of first pH or (3) the cells succumb immediately after changing to the exposure of second pH.

Possible mechanism of recovery in such cells has been discussed.

76. Excretion in Arachnids. I. Scorpion.

M. S. KANUNGO and S. C. BOHIDAR, Cuttack.

Chemical, spectrophotometric and paper chromatographic (ascending) tests were carried out to investigate the nature of the excreta of the scorpion, *Palamnaeus bengalensis*. The greyish-white excreta is soluble in dil. sodium carbonate and has a maximum absorption at 250 mμ. All the above tests have shown the presence of purines, adenine, hypoxanthine and uric acid. Guanine, in addition to all the above purines, was also detected in the excreta of the spider. It is considered that the animals excreting several intermediates of the same excretory cycle, for example, the scorpion and spider, are physiologically less evolved than those excreting only one intermediate of the same cycle, for example, the insects which excrete only one purine, uric acid.

77. Changes in the localisation of alkaline phosphatase due to centrifugation in *Acanthamoeba* sp.

D. MUKHERJI, Calcutta.

Trophic forms of *Acanthamoeba* sp. were centrifuged for different time intervals and these were subjected to cytochemical tests to ascertain the nature of sedimentation produced. Localisation of alkaline phosphatase was closely followed till 48 hours after centrifugation. It has been observed that the centrifuged amoebae show alkaline phosphatase positive granules mobilised at the periphery. These phosphatase positive granules are often condensed as channels radiating from the nucleus to the periphery.

Localisation of alkaline phosphatase in centrifuged amoebae reveals that a degree of differential sedimentation results in cytoplasm which becomes rarely perceptible in amoebae processed by ordinary way.

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78. Physiological trends in Janus green B treated cells.

SIVATOSH MOOKERJEE, M. CHOUDHURY and B. GANGULY, Calcutta.

In the present set of experiments, the reducing ability of a supravital stain, Janus green B by amoeboid cells in sponges has been studied under the impact of different pH and temperature gradients.

A concentration of Janus green B solution over 0·2% immediately disintegrates the cell. Lesser percentages have other physiological effects. However, concentration of 0·006% has no adverse effects in the cells. In the last solution the colouration of the granules remains for 30 to 45 minutes, after when it is reduced. The general trend of results in various concentrations in between 0·2% and 0·006% show the following features : (1) Enlargement in cell size, (2) cessation of cytoplasmic movement with thickening of cell membrane, (3) development of a number of vacuoles in peripheral region with numerous particles in them.

Exposure to different experimental conditions, i.e., in high and low temperature and pH, neutralises the above mentioned effects of Janus green B.

In treated cells, as soon as vacuoles develop, surface movement ceases. Disappearance of vacuoles makes the movement returned to the cell. Vacuoles stand in the way between plasma membrane and cytoplasm and free interplay of surface is prevented.

79. Cell lineage in Nucleic acid treated amoebae.

SIVATOSH MOOKERJEE and JAYANTA K. DATTA, Calcutta.

Inside the nucleus, DNA, the most stable molecular content, has not only the overall control over all jurisdiction of a cell but also its subsequent progenies. DNA is modifiable under a host of extraneous sources like X'rays, chemical mutagen, etc. Here is an attempt to expose the trophic forms of amoebae to the effects of nucleic acids of thymus and yeast. The chief significance of the experiment is to observe how does the self-perpetuating model of a cell, as typified in amoeba, react to the action of nucleic acids and form subsequently its own cell lineage.

The effects of nucleic acids on amoeba are important for more than one counts. It induces almost immediately higher granulation in cytoplasm, thickening of cell surface and occurrence of higher vacuolisation. The thickening of the surface takes place in such a way that soon cell membrane becomes immobilised and gives a false impression of an encysted condition. Such changes are observed in amoebae originating after divisions from the ones treated before with nucleic acids. Such trends linger on in trophic forms for two to three subcultures. In each subculture, there is a few hundred division of original trophic forms, i.e., the nucleic acid-induced-changes persist in daughter cells. However, by repeated subculture for more number of times, physiologically altered stake in amoeba can be got rid of. But repeated treatment with nucleic acid in consecutive subculture 'kills' the organism.

The implication of the transient structural changes in amoeba brought about in the cell body as a result of nucleic acid treatment has been discussed in the light of DNA permanency and cell lineage.

80. Cytochemical changes in relation to synthetic activity in fatbody cells.

SIVATOSH MOOKERJEE and AJAY KUMAR RAY, Calcutta.

Cytochemical configuration of fatbody cells of *Periplaneta* has been investigated in normal and experimental conditions. Animals were first starved and

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the fatbody tissues were fixed on the 7th, 14th, and 21st day of starvation. After 21 days, they were fed with protein and carbohydrate diet separately and fat body cells were fixed after 2, 3, 4 and 5 days. Starvation results in progressive depletion of cytoplasmic basophilia, condensation of chromatin material, discontinuity of nuclear membrane, loss of Feulgen stainability and fragmentation and disorganisation of nucleolus. Feeding leads to gradual recovery of the cytoplasm and nucleus to normal configuration. Recovery is more rapid after protein diet.

The significance of cytochemical changes has been discussed in relation to synthetic activity of the fat body cells.

81. Transient physiological changes in trypsinised amoebae.

S. MOOKERJEE and P. L. D. WAIDYASEKERA, Calcutta.

Physiological changes occur in cell body of amoeba originated by repeated treatment with 0·2% Bacto-trypsin. Cysts obtained after treatment, if subjected to successive subcultures, show certain physiological changes in trophic forms in having about double the volume of the cell, occurrence of more vacuoles, and 'unequal divisions'. These changed physiological trends return to normalcy after 4th successive subculture. If retreatment by Bacto-trypsin is carried on in each subsequent subculture, emergent amoebae tend to minimise their size, and ultimately by the 4th retreatment, they become non-viable and no more subculture is possible from the cysts formed out of them.

The aspect, related to the question of amoebae becoming normal after the first treatment by repeated subculture, has been followed in detail. Two kinds of amoebae formed by the 'unequal division' show difference in basophilic localisation; the denser is the smaller and the lighter one is the larger. The cutting of giant amoebae into unequal halves seems the major mechanism of returning the trophic forms into normal condition. Cell division, as it is understood, is under the control of nucleus. One can advance on the basis of the present result that the effects of 0·2% Bacto-trypsin in trophic amoebae seem to be of a transient nature, because the effects are regularised by some compensating mechanism possibly originating from nucleus which is eventually transacted into cytoplasm.

82. Occurrence of a Hypoglycemic factor in the eyestalks of freshwater crab, *Paratelphusa jacquemontii* (Rathbun).

P. V. RANGNEKAR and P. B. SABNIS, Amravati.

1. Extirpation of eyestalks results in a rise in the sugar concentration of blood, when compared with sham operated controls.
2. Injection of eyestalk extract in eyestalkless animals lowers blood sugar level considerably. This fall in the concentration in the blood sugar represents a hypoglycemic condition. In the control experiment injection of equivalent quantity of saline in eyestalkless crabs shows a rise in blood sugar concentrations as expected.
3. Injection of eyestalks extract in intact animals results in a remarkable fall in blood sugar level and the effect is all the more striking than that observed in eyestalkless animals. In the control experiment injection of equivalent quantity of saline had no significant effect on blood sugar level.
4. The amounts of free glucose in hepatopancreas, however, showed some interesting changes under different conditions. Thus, after removal of eyestalks the glucose concentration was lowered. It remained almost at a normal level after administration of eyestalk extract in eyestalkless animals as well as in

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those with eyestalks. This suggests that there is a mobilization of free glucose in hepatopancreas following ablation of eyestalks. Eyestalk principle has no significant effect on glycogen level.

5. The action of hypoglycemic factor is analogous to that of insulin on blood sugar concentration in higher vertebrates. Our experiments lead to a more specific localization of a hypoglycemic factor in the eyestalks.

83. Cellular source in hydroid regeneration.

SOMES SANYAL, Calcutta.

The cellular source in regenerating structures of hydroids has not yet been settled. A survey of the changes in total cell population of three cell-types *viz.* epitheliomuscular, interstitial and cnidoblast in ectoderm during hydranth regeneration in *Hydra vulgaris* has been undertaken. The total counts show that overall cell population does not increase during regeneration; on the contrary, there occurs a sharp decline in the number of cells participating in the reconstitution of the pattern. Most conspicuous is the loss of interstitial cells and to a lesser extent of epitheliomuscular cells during first 24 hours after amputation. A little loss is also encountered during 24-48 hours. The total population of cells becomes more or less stabilized as regeneration nears completion during 48-72 hours. However, the number of cnidoblasts are gradually increased during the entire process.

It is attributed that regeneration involves remodellling of the available material and that interstitial cells do not differentiate into other cell-types except cnidoblasts during regeneration.

84. A causal analysis of morphogenesis of Hydra during bud development.

SOMES SANYAL, Calcutta.

This work has been designed to study the morphogenetic basis of determination and individuation in bud development of hydra. Three sets of experiments have been performed, first, the bud portion protruding from the parent hydra in the different stages of development have been explanted; secondly, the parent hydranth and stem distal to the bud have been removed and lastly, segments from different levels of an early stage bud have been isolated. Developmental fates of explants and the parent hydras and their time sequence compared to the control show that a bud originates as a radially determined area, in which the presumptive hypostome, tentacles, stem and basal disc are already determined at the early stage and occupy successive radial segments centrifugally from the centre. Ability of a developing bud to replace the distal parts of the parent hydra is dependent upon the nature of determination of its basal disc. Regenerative potencies at the different levels of an early bud correspond to the same of an adult hydra and actual regeneration does not occur until the bud development is complete. Individuation of the bud into an adult hydra becomes expressive as the developmental potencies of the differentially determined bud area are realised.

85. Distribution of some histochemically demonstrable cytoplasmic constituents in the kidney of Lizard.

C. SARKAR and C. DEB, Calcutta.

The distribution of some histochemically demonstrable cytoplasmic constituents has been studied both in the proximal and distal tubules of the kidney of garden lizard,

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Succinic dehydrogenase, glucose-6-phosphatase and acid phosphatase in proximal convoluted tubules of lizard were similar to mammals but it contained lesser amounts of esterase, plasmalogen, alkaline phosphatase and P. A. Schiff positive substances (not glycogen). Most of the constituents were present in the distal convoluted tubules in a lesser amount, excepting acid phosphatase which was of much higher concentration. The apical portion of the cells of the distal tubule conntained considerable amounts of unsaturated lipids and lipase but not esterase. R.N.A., both total and some individual amino acids were also present in this portion in a lower concentration. It has been observed previously that the concentration of different cytoplasmic constituents in kidney is related to its functional activity. The observed changes in the kidney of lizard also suggests a difference in function compared to mammals.

86. Host-graft interaction in the determination of implanted material in Hydra.

ARUP SINHA, Calcutta.

Recently Mookerjee has shown that implantation of middle piece at the anterior level of another hydra results in the production of a basal disc and a hypostome at the posterior region, and the visual appearance of differentiation in the implant is seen after the lapse of 48 hours of experiment. The above demonstration was put to further experimental test to analyse the factors involved in the latent period of tissue interaction Three experiments were designed :

Experiment I : Excision of a portion of the implant
Experiment II : Excision of whole of the implant
Experiment III : Excision of the implant with equal amount of the host tissue.

All these experiments are performed at 24 hours' as well as 48 hours' stages and the excised portions are used as explants and cultured independently.

The explants in experiment I and II develop into a miniature hydra at 24 hours' stage but at 48 hours' stage they round up and show stickiness The explants of both the stages in experiment III develop into miniature hydras. But they are qualitatively different. In 24 hours' stage the anterior half including the hydranth is contributed by the implant and the posterior half including the basal disc is contributed by the host tissue, whereas in 48 hours' stage the case is just reverse. The findings establish the duration of a latent time period required for channelising the determination which is again dependent upon host-graft relation.

87. Histochemical study of Alkaline Phosphatase and Glycogen in the alimentary canal of certain Fish in relation to differences in their feeding habits.

ANIL KUMAR SRIVASTAVA, Gorakhpur.

Mastacembelus pancatus, a herbivore, *Heteropneustes fossilis*, an omnivore and *Ophicephalus striatus*, a carnivorous fish have been used for the histochemical study of Alkaline phosphatase and Glycogen.

Alkaline phosphatase occur abundantly in the free border of the absorptive cells of these fishes. In *Heteropneustes* and *Ophicephalus* the staining intensity decreases in the rectal region. *Mastacembelus* shows no enzyme in the rectum. The fibres in the subepithelial connective tissue also show phosphatase activity. *Heteropneustes* and *Mastacembelus* show positive results in granular cells. In *Ophicephalus* the stratum compactum contains alkaline phosphatase.

Pharynx, esophagus, stomach contain this enzyme; its intensity being the greatest in the basal layer of the stratified epithelium.

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Glycogen was found scanty in the absorptive cells; it being absent in the stomach altogether. Granular cells of *Heteropneustes* and *Mastacembelus* contain glycogen; Ophicephalus gives negative results.

The investigation throws light on the absorptive function of alkaline phosphatase. It possibly absorbs glucose. Glycogen-localization closely follows the distribution of alkaline phosphatase (*viz.* in *Heteropneustes* and *Mastacembelus*). Therefore, glycogen-formation, perhaps, depends upon the dephosphorylation of hexose phosphate and the condensation of hexose molecules to form glycogen. Alkaline phosphatase might well be concerned in this dephosphorylation-process and so be concerned in the deposition of glycogen.

FISHERIES

88. Observations on the possibilities of inducing Pearl-formation in the freshwater bivalve, *Lamellidens lamellidens*.

K. H. ALIKUNHI, Cuttack.

Production of culture pearls by utilising the marine pearl oyster, *Pinctada martensii* is a flourishing industry in Japan. The large freshwater clam *Hyriopsis schlegelii* is also employed for producing pearls.

Lamellidens lamellidens is one of the common bivalves in Indian freshwaters and occurs in abundance in fish ponds at Cuttack. Certain preliminary experiments were carried out to find out whether pearl production could be induced in this species.

Shells conditioned for two weeks were operated and mantle grafts were introduced in the visceral mass. The operated shells were kept in wire-net trays in ponds for varying periods. 6 to 12 months after the operation almost all the surviving shells were found to have produced golden pearl-like concretion of various shapes at the places where mantle grafts were introduced. Further observations are in progress.

89. Fecundity, Breeding and life-history of a minor carp Labeo boga (Hamilton).

K. H. ALIKUNHI, S. PARESMASWARAN and K. K. SUKUMARAN,

Cuttack.

Labeo boga is one of the minor carps that commonly occurs in the carp spawn collected from the Mahanadi. In ponds it attains maturity when it is about one year old. Specimens 15 cms. or above in length are found with ripe gonads during June-July. Fecundity counts of 25 specimens ranging from 15·1 to 24·0 cm. in length show that the number of ovarian eggs ranges from 11,670 to 1,13,900.

Like other Indian carps *L. boga* also does not ordinarily breed in ponds. Ripe specimens were repeatedly induced to breed by intra-muscular injections of Rohu pituitary glands at a minimal dose of 7·6 mg./lb. for female and 6 mg./lb. per male. In hapas fixed in pond, the fishes spawned, 6-8 hours after the injection. Percentage of fertilisation of eggs ranged from 81·5 to over 92. The fully swollen, developing egg has a maximum outer diameter of 3·0 mm., the egg proper measuring 0·95 to 0·997 mm. in diameter. Cleavage commences within half an hour of fertilization and embryo is indicated within the next four hours. 8 hours old embryo shows occasional twitching movement. 14 to 17 hours after fertilization

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the embryo hatches out. The hatching, about 3·75 mm. long, has the yolk almost completely absorbed in about 24 hours, in the pond. In Laboratory aquaria the larva has all the fins fully differentiated in about 12 days after hatching.

90. Preliminary observations on Chinese Carps in India.

K. H. ALIKUNHI and K. K. SUKUMARAN, Cuttack.

An experimental consignment of 360 fingerlings of the Chinese Silver carp, *Hypophthalmichthys molitrix* was brought from Tokyo to Cuttack on 1st September 1959 and a similar consignment of 382 fingerlings of the Chinese grass carp, *Ctenopharyngodon idellus* was brought from Hong Kong on 22nd December 1959. Observations made on these exotic, quick growing major carps during the last 22 months are briefly discussed in this paper.

Silver carp is a plankton feeder and preliminary observations on its growth in ponds indicate that it is decidedly faster than that of *Catla catla,* the fastest growing Indian carp. Sexual maturity is attained, at Cuttack, when the fish is just two years old. Marked roughness of the outer surface of the pectoral fin distinguishes the ripe male from the female. Two years old fish have attained an average weight of 4·5 Kgs., the maximum observed being 6·5 Kgs.

The grass carp feeds voraciously on aquatic weeds. *Hydrilla, Lemna, Azolla, Lagerosiphon* etc. are particularly favoured. Preliminary experiments indicate that nursery ponds choked with *Hydrilla* can be completely cleared of weeds in the course of a month by introducing 25-30 cms. long grass carps at the rate of 100 to 150 per acre. Two years old males weighing 2 to 3 Kgs. were sexually ripe and oozing but the females (2·5 Kg. to 3·5 Kgs.) were not mature.

91. Some Observations on the Pollution at Okhla Water Works Intake, Delhi.

MOHAN C. BALANI, and H. L. SARKAR, Delhi.

In the present paper an attempt has been made to determine the extent of pollution at Okhla Water Works Intake, during the monsoon months. The Okhla Water Works whose capacity is 3 MGD is situated on the downstream of the river Jumna and suffers a good deal of pollution.

Barapulla nallah is one of the thirteen nallahas of Delhi and drains the sewage of the major portion of South Delhi, in the river Jumna, hardly two furlongs down the Okhla Weir. The nallah has strong mud embankments and is about 15 miles in length with an average 5′-6′ width and 1′-2′ depth. The velocity of the effluent in the nallah varies between 0·5′-2·0′ per second. The effluent in its normal flow, after passing beneath the Agra irrigational canal, is discharged in the river Jumna down the Okhla Weir. During the monsoon months, sewage of the nallah cannot pass through the narrow channel leading to its normal course. It thus takes straight course towards the river Jumna. A *kuchha bund* erected to prevent the sewage flow in the river, gives way during the monsoon months, with the result the effluent is carried into the river Jumna, hardly 40 yards upstream of the Okhla Water Works Intake, situated on the same bank.

Physico-chemical observations like turbidity, pH, dissolved oxygen, chloride, free ammonia, and albuminoid ammonia were carried out in the months of July, August and September 1960 at three spots, i.e., Barapulla nallah, Okhla Intake and upstream. The data collected have revealed that the water pumped from the Intake shows pollution due to the overflow of the Barapulla nallah.

Care must be taken by the municipal authorities to stop the pollution of the Intake water during the monsoon months.

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92. Soil nutrients and plankton production in fish ponds. A. Available Soil phosphorus.

S. M. BANERJEA and A. N. GHOSH, Cuttack.

Bottom soil in a pond appears to act as a reservoir of nutrient elements like nitrogen, phosphorus, potassium, calcium etc. wherefrom they are supplied to the water. The quantity of plankton, which forms an important link in the food cycle for fish, is largely determined by the availability of these elements from the soil to the water. So, a study of possible relationships between different levels of available nutrients in the bottom soil and plankton production was considered necessary to determine a judicious programme of fertilisation for fish ponds. As phosphorus is known to play a dominant role, the effect of increasing the available phosphorus content in a phosphorus deficient soil which was sandy in texture and slightly acidic in reaction, on plankton production was studied both in the laboratory as well as in the field. The available phosphorus content (40 p.p.m. P_2O_5) was initially raised to three different levels of 80,120 and 160 p.p.m. in the laboratory experiment and to 80 p.p.m. only for the field experiment, by adding the requisite quantity of double superphosphate (32% P_2O_5). A progressive increase in plankton concentration for the different increased levels of available phosphorus in soil was observed both in the laboratory and in the field experiments which continued for 12 and 6 months respectively. In this particular soil-type with low total nitrogen of which more than 60% was present in the available form maximum production of plankton was obtained when the ratio of available nitrogen : available phosphorus was approximately one.

93. Studies on the biology of the Goby, *Glossogobius giuris* (Hamilton).

R. M. BHOWMICK, Barrackpore.

Study of the length-weight relationship of over 1288 specimens revealed the following : In male $W=10-5\times0{\cdot}87338\ L^{2{\cdot}9554}$. In females $W=10-5\times0{\cdot}91381\ L^{3{\cdot}0457}$. In specimens over 85 mm. length the males are distinguished from the females by the relatively long, thin genital papilla.

Just over 20% of the females mature at a total length of 76 mm. percentage of maturity gradually increases with increase in size and all females measuring 186 mm. and above are mature. The various stages of maturity have been described.

It is found that juveniles have preference for crustacean food, especially copepods. Large specimens 90 mm. or above do not show such preference for copepods. They are omnivorous in habit, showing marked preference for fishes and prawns. Cannibalistic tendency is not found to be pronounced.

Fully mature specimens are obtained almost throughout the year but the peak period of breeding is from August to October. Fecundity increases with the increase in size. Number of ovarian eggs varies from 1·9 lakhs to 6·5 lakhs in specimens ranging from 11 cm. to 24 cm. in total length.

In the Hooghly estuary (Nabadwip area) during the month of February about 12·5 maunds of *G. giuris* are landed, contributing 21% of the miscellaneous fishes caught.

A new type of fishing net with a scare-line for catching bottom fishes especially gobies, has also been described.

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94. Fish culture in a swamp in Chetpat, Madras City.

P. I. CHACKO and J. G. ABRAHAM, Madras.

A typical swamp overgrown with vegetation and containing predators, is utilised for systematic fish culture on a phased programme. Water-area is 10 acres in extent, and depth ranges from 1 to 10 feet. Plankton consists of diatoms, algae, copepods, daphnids and rotifers. Range of temperature of water is 27·5-37·2°C at surface and 26·2-36·5°C at bottom. Quantity of fish landed and marketed has been 1552 lbs. in 1955-56, 2133 lbs. in 1956-57, 2644 lbs. in 1957-58, 5124 lbs. in 1958-59, 6767 lbs. in 1959-60 and 6831 lbs. in 1960-61, thus increasing the annual fish production from 155·2 to 683·1 lbs. per acre. Important forms contributing to the fishery in order of abundance are *Tilapia mossambica, Catla catla, Ophicephalus striatus, Cirrhina reba, Labeo fimbriatus, Labeo rohita, Etroplus suratensis, Chanos chanos, Cirrhina cirrhosa, Notopterus notopterus and Mugil cephalus.* Of these *Tilapia* formed 82 per cent of the landings in 1960-61. Swampy waters appear to be suitable for this fish. It averaged 3-5 inches in size and 2 ounces in weight.

95. An unusual drifting of *Glaucus marinus* (Du Pont) from the Bay of Bengal into the Ennore river near Madras.

P. I. CHACKO and A. RAJAGOPAL, Madras.

Glaucus marinus is a pelagic nudibranch occurring in the Bay of Bengal. It is 30-50 mm. in length. It floats on its back and its upturned blue ventral surface simulates with the marine environment. Though thrown up along Madras beach occasionally, an unprecedented instance of innumeral specimens of this species getting drifted into the Ennore river-estuary occurred on 28-29 December 1960. They were thrown along the southern shore of the river to form a belt one kilometre long and one metre wide with a density of 200 specimens per square metre. Following few days of cyclonic weather conditions, these nudibranchs appear to have got congregated into a mass by a depression and whirlpool in the Bay and then drifted towards the shore by current and then cast into the river during high tide. The low salinity of 17·32 parts per thousand of the estuary water would have caused mortality. This instance is a typical example of the influence of weather and oceanographic conditions on life and survival of marine organisms.

96. Hydrobiology and fisheries of the Ennore river, near Madras from April 1960 to March 1961.

P. I. CHACKO and A. RAJAGOPAL, Madras.

The estuarine region of river extended to 12 furlongs in length and 4 furlongs in width. Depth of water was 3 to 5 feet. It had connection with the sea from November to March. Rainfall, humidity and atmospheric temperature was 42·15 inches, 51-96 per cent and 24·0-36·5°C. Surface water temperature, specific gravity, pH and salinity were 28·5-35·0°C, 1,000-1·028; 7·4-8·9 and 0·2-46·7 p.p. 1000. Plankton sedimentation was 1·0-500 cc per litre of 20 minutes haulage. *Coscinodiscus, Rhizosolenia,* copepods, nauphii, larvae, zoea larvae, megalopa larvae and larval prawns were common. Fishery totalled 255 tons. Mullets were 40% of langings. Cat fishes, Silver bellies, Horse-mackerals, Gizzard shad, Whiting, pearl spot, squeaking perch, Silver perch, prawns and crabs were the other main fisheries,

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97. Further observations on the breeding of Milk-fish, *Chanos chanos* in the inshore waters of Rameswaram.

P. I. CHACKO and S. DAVIDSON THOMAS, Madras.

In the course of operation of bottom-set gill nets made of nylon twine of 50-60 lbs breaking strength and of 5, 6 & 7 inches mesh in inshore waters off Rameswaram in 1960, large specimens of Chanos were obtained during all months except in February. Depth of fishing grounds was 3-4½ fathoms and their bottom were sandy. The specimens ranged from 28 to 36 inches in size and 6·40 to 8·66 lbs. in weight. There were two peak periods of occurrence in May-June and in November, when the female specimens were gravid. Some specimens obtained in June, July, November and December were spent ones. These observations confirm that adult chanos occurs in the bottom waters of the inshore area and breed close to tidal creeks and mud flats twice a year..

98. Breeding of *Puntius sarana* (Hamilton) and observations of its life-history and bionomics.

HIRALAL CHAUDHURI, Cuttack.

Puntius sarana (Hamilton) like other major and medium-sized Indian carps does not ordinarily breed in confined waters. The author has successfully induced this species to breed repeatedly by injection of fish pituitary extracts. It has also been possible to make it breed in a small pond by maintaining a flow of accumulated rain water without any injection.

A complete account of the life-history is included in the paper. Developing eggs are demersal, range in size from 1·2-1·4 mm. in diameter and hatch out within 13-17 hours. Distinguishing characters of the larvae, post-larvae, fry and fingerlings have been described. The food and feeding habits of the fish have been discussed.

99. Breeding and life-history of *Rasbora elanga* (Hamilton).

HIRALAL CHAUDHURI, Cuttack.

Rasbora elanga (Hamilton) attaining a length of 20 cm. or above is an esteemed food fish in Bengal, Assam and Burma. Like other Indian carps is does not breed in ponds.

The fish was bred by injection of fish pituitary hormones. The fertilised eggs swell up considerably and are non-adhesive and demersal in nature like the eggs of major carps. The average diameter of the egg is about 2·7 mm. The yolk has a slight orange tinge. The newly hatched larva measures about 4·4 mm. in total length. The hatchings were reared in the laboratory up to the fingering stage and various stages of life-history studied in detail. Adult characters are attained in the course of 10 days after hatching.

Characters distinguishing sex of breeders are also described.

100. Induced breeding and development of a common Catfish, *Ompok bimaculatus* (Bloch).

HIRALAL CHAUDHURI, Cuttack.

The paper gives a complete account of the life-history of the widely distributed catfish *Ompok bimaculatus* (Bloch). The species was successfully bred in cisterns

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by injection of carp pituitary extract and the developmental stages were studied in detail. The eggs are reddish-brown in colour, non-adhesive, demersal and measure about 2·0 mm. in diameter. They hatch out within 14—17 hours after fertilisation. About six hours after hatching, a sticky substance is secreted by the hatchlings from the ventral region of the yolk mass. By means of this secretion they stick on to some substratum and constantly move their head and tail sideways. The hatchlings were reared in the laboratory anl thereafter in ponds to fingerling stage. Adult characters are attained in the course of 15 days after hatching.

The characters distinguished sexes during the breeding season have also been described.

101. Observations on induced breeding of major Indian carps during 1960 at Cuttack.

H. CHAUDHURI, R. M. BHOWMICK, R. N. PAL and A. B. MUNSHI, Cuttack.

Experiments carried out at Cuttack during June to September, 1960, on induced breeding of Indian carps by pituitary hormone injections are described.

116 sets (a set consists of one female and two males) of major carp breeders (*Catla, Rohu, Mrigal* and *Calbasu*) were injected with 60% successful results. Spawning was partial in a few cases. In the majority of successful spawnings, the percentage of fertilisation of eggs was over 70, the maximum being 98·5.

Intramuscular, homoplastic injections were administered in the majority of cases. Spawning occurred after one, two or rarely three injections. For breeders ranging from 0·01 Kg. to 5·9 Kg. the successful dose of single injection ranged from 0·2 to 1·5 glands for females and 0·05 to 0·9 glands for males. When two injections were required the total dose ranged as follows :

Males	...	...	0·15 to 1·3 glands
Females	...	...	0· 3 to 3·0 glands

The injected breeders were released in cloth *hapas* fixed either in ponds or in the river. Developing eggs were hatched out inside a double hatching *hapa*. About 82 lakhs spawn were stocked in nursery ponds on the third day of hatching.

The paper includes details of the breeding and hatching techniques followed.

102. Observations on the utilisation of food by the major carps.

M. G. GEORGE, Delhi.

The observations on the utilisation of the food in *Labeo rohita, Catla catla, Cirrhina mrigala* and *Labeo calbasu* have revealed that all the food items that are consumed are not of equal importance to the fishes. The blue-green algae, euglenoids and fungal spores are not utilised by the fishes as they reappear fresh in the hindgut. It was surprising to find that among the green algae, filamentous forms like *Oedogonium* and *Spirogyra* were digested by the fishes, while some of the smaller forms like *Scenedesmus* and *Kirchneriella* were not acted upon by the digestive enzymes. However, it has not been possible to find whether the fishes were feeding on the senescnt filaments of the algae in which case digestion may be easy. The diatoms are digested by the fishes as only broken shells were noticed in the hindgut. Thus among the major algal groups, only the members of Bacillariophyceae were digested. Whenever zooplankton were taken, they were digested.

Since many of the algae pass through the ailmentary canal undigested, it is quite likely that these algae may be appearing again as the standing crop of

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plankton. Also the selective digestibility may have a profound effect on the composition of plankton.

103. Growth and propagation of Common carp *(Cyprinus carpio)* in India. IV. Observations on the size of eggs, hatchlings and fry of parents of various size.

K. V. RAMAKRISHNA and K. H. ALIKUNHI, Cuttack.

In India the Common carp (*C. carpio. var. communis*) starts breeding when it attains a length of 18 to 20 cms. Mature specimens ranging from 0·12 Kg. to 6·0 Kg. and over are used in experimental and commercial breeding.

Detailed observations on the size of eggs laid by and the length of hatching and fry obtained from breeders of various size were made and it was found that generally the eggs of smaller specimens are smaller than those of larger ones. The same trend was observed in the case of hatchlings and fry also.

The size of hatchlings and fry varied when eggs from the same batch were hatched in different habitats.

Rearing fry of specimens of widely different size, under identical conditions in the laboratory indicate that fry of the bigger fishes maintain their initial size advantage at least during the early rearing period.

The significance of these findings in practical fish culture are discussed.

104. Physico-chemical and Biological conditions in selected paddy fields in Orissa, with special reference to fish culture.

G. N. SAHA and K. V. RAMAKRISHNA, Cuttack.

An assessment survey of paddy fields as an environment for fish culture was conducted in Cuttack, Puri, Ganjam and Sambalpur districts of Orissa. Fluctuations in water, soil and plankton conditions in 26 plots (15 under winter paddy and 11 under summer crop) selected at random were periodically studied for one year.

Plankton in all the plots was relatively poor. Zoo-plankters like *Cyclops, Nauplii, Brachionus* and *Polyarthra* predominated. *Euglena* and *Peridinium* were common. Phytoplankton blooms were rarely met with.

Water and soil conditions do not seem to permit rating paddy fields as a productive habitat for fish, particularly plankton feeders. The paucity of plankton in the field is probably the result of paddy plants thriving there, as an emergent macro-vegetation for the aquatic phase.

105. Observations on biology of the two species of diaptomids, *Heliodiaptomus viduus* Gurney and *Neodiaptomus strigilipes* Gurney commonly occurring in fish ponds at Cuttack.

K. L. SEHGAL, Cuttack.

The paper deals with observations made on the biology of two species of diaptomids, H. *viduus* and N. *strigilipes*. The gut analysis of 174 specimens of H. *viduus* and 153 specimens of N. *strigilipes*, collected round the year from nursery ponds at Cuttack indicates that they feed mainly on microscopic algae, diatoms, protozoans and rotifers. The composition of food on the average has been found to be as Myxophyceae—70·0%; Bacillariophyceae—14·0%; Euglenineae—4·1%; Chlorophyceae—1·9%; Protozoa—7·0% and Rotifera 3·0%. Culture experiments carried out under laboratory conditions suggest that temperature has some role to

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play in the rate of reproduction and survival of nauplii and copepodids. Use of organic manure was found to enhance propagation of the two species. The number of eggs in a sac ranged from 9-29 in H. *viduus* and 7-24 in N. *strigilipes*. Average diameter of eggs before hatching has been measured as 0·061 mm. in *H. viduus* and 0·045 mm. in N. *strigilipes*. The hatching of eggs was by osmotic swelling of the inner egg membrane which takes place 4-6 hours prior to liberation of nauplii. The hatching of the eggs was not simultaneous. They hatched in batches of two or three. There are six naupliar and five copepodid stages during development. H. *viduus* took 96-112 hours to complete the six naupliar stages and 10-15 days to complete the whole life-history. N. *strigilipes* required 91-103 hours for six nauplii and 8-13 days to complete the life cycle.

106. Observations on the Biology of *Oxygaster gora* (Hamilton) at Allahabad, Uttar Pradesh.

K. L. SEHGAL and S. B. SINGH, Cuttack.

Oxygaster gora (Hamilton) attains a length of 27·0 cm. or above in the rivers Ganga and Jamuna at Allahabad. The length-weight relationship was found to be in a straight line and in the specimens up to 17-19 cm. sixe-group, the increase in weight was at a slower rate than in the subsequent size-groups. Detailed analysis of the gut contents of over 90 specimens indicated the average composition of diet as fish—67·5%, insects—26·6%, Crustaceans—3·8%, and algae—2·1%. The intensity of feed was moderate during winter and summer months but was poor in rainy season. Study of maturity and spawning indicated that the fish matured during March to June and the peak spawning season was from April to May. In the ovaries of fully mature females of average length, 22·1 cm. 23,000 eggs were counted. The sex ratio of males to females was 1 : 2 and the males were smaller in size than the females. The post-larvae and juveniles were found in abundance in the two rivers from April to July.

107. Control of some emergent and floating water weeds by Taficide-80.

S. B. SINGH, Cuttack.

Taficide-80 and 80% Sodium salt of 2, 4-dichlorophenoxy acetic acid, @ 5·6 Kg./hect. has been found effective in the control of *Nelumbium speciosum* Willd. (Lotus), *Euryale ferox* Salisb. (prickly water lily), *Nymphaea* spp. (Water lily) and *Eichhornia crassipes* Solms. (Water hyacinth) in fishery waters. With proper coverage and in the absence of rains complete kill of sprayed leaves is obtained within three to seven weeks' time. A second treatment after two to three weeks in th case of lilies and lotus, to kill any new leaves that might have been renewed from the bottom, frequently results in permanent clearance. This is not required in the case of *Euryale* where the leaves are large, corrugated, without waxy coating, and the chemical does not get easily washed off. Complete clearance of the plants with one treatment in some of the trials probably suggests that the chemlical is translocated to the underground part as well.

The cost of chemical required for a single treatment in the case of the above weeds worked out to Rs. 44/- per hectare.

In experiments on *Pistia stratiotes* Linn. (Water lettuce) complete kill of the plants was obtained @ 11·2 Kg./hect. and 5·6 Kg./hect. in four weeks' time in cement cisterns during bright weather and with uniform spraying, but not in the field probably owing to rains and other reasons.

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108. Two cases of discolouration of Squids.

A. SREENIVASAN, Bhavanisagar.

The squid, *Omnastrephes sloani pacificus* forms a high percentage in the fish catches of Japan. Its preservation is therefore of importance. In one case the squid treated with O.T.C. (terramycin) and stored at ice-temperature was found to develop a yellow discolouration. This was traced to a bacterium resembling *Pseudomonas putida*. This culture tolerated a concentration of 100 p.p.m. of O.T.C. This was a psychrophilic organism reducing trimethylamine oxide. The second instance of discolouration was caused by a species of Serratia, but this occurred at temperature above 25°C, the squid turning red by the growth of this organism. But this failed to occur at 4°C and the bacterium itself failed to grow at this temperature. This culture tolerated 400 p.p.m. of O.T.C. Tolerance of such high concentration of the antibiotic is interesting, since the greatest amount tolerated by *Serratia marcescens* is only 200 p.p.m. as reported by Castell (1959).

109. Fat Variation in a Fresh Water Fish, Labeo fimbriatus.

A. SRINIVASAN and R. SOUNDERARAJ, Bhavanisagar.

In migratory marine fishes, variation of fat with season and sexual maturity has been noted but as regards fresh water fishes information is taking. *Labeo Fimbriatus,* which was introduced into the Bhavanisagar Reservoir from Cauvery, has grown well and it occurs regularly in the experimental fishing catches. Periodical analysis of the fat, moisture and protein of this fish has been carried out since January 1961. The fat content does not show any seasonal pattern. Size also does not seem to infiuence the fat content of the flesh. Nor is the fat content corrected with the "condition factor". In the case of female fish of the fat does not increase with increasing maturity. For instance females in the fifth stage had as low a fat content as 1·61% and 1·63% respectively on two occasions while a female in the first stage of maturity had fat content of 6·68%. In the male fish however there were indications of increased fat content with increasing maturity, and this appeared to have a seasonal pattern. Instead of an inverse correlation of fat and moisture, very peculiarly, there appeared an inverse coorrelation of fat with protein, the latter decreasing with increasing fat content in the male. These results differ in some respects with these for *Barbus dubius, Wallago attu* and *Macrones aor* (Sri Srinivasan and Natarajan 1961). Further results will indicate the exact trend of fat variation. The range of fat noted till now is 1·05 to 8·88% for sizes 1816 g. to 4767 g. of the fish.

110. Experiments on inducing spawning of Indian carps by injection of fish pituitary hormones during 1959 at Cuttack.

M. A. VIJAYALAKSHMANAN, R. N. PAL, K. K. SUKUMARAN and K. V. RAMAKRISHNA, Cuttack.

Catala Catla, Labeo rohita and *Cirrhina mrigala* were successfully and repeatedly spawned by injection of fish pituitary hormones and about 3 million spawn were produced and stocked in nursery ponds for rearing.

Pituitary glands preserved at room temperature for 2-3 months were successfully used to induce spawing at doses comparable to glands preserved at low temperature. Pituitary glands of common carp (*Cyprinus carpio*) induced successful spawning

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in Rohu and Mrigal ; Rohou glands induced spawning in Catla, Rohu and Mrigal and similarly Mrigal glands in Rohu and Mrigal.

Some of the fishes responded to a single injection and spawned within 8 to 12 hours. Majority of specimens spawned after the second injection, within 24 hours; while a few of them spawned after the 3rd injection also. Spawning was induced in 51% of the breeders injected. Fertilisation of eggs in some was very low, while in others it was as high as 98%. Injected fish spawned at night as well as during daytime, in all types of weather conditions.

A Rohu female that spawned in 1958 and was subsequently kept separate in a pond developed gonads normally during 1959 when it was again bred by a single injection of hormones.

Details of injections given, number of eggs laid, percentage of fertilisation and hatching techniques applied are discussed in the paper.

HELMINTHOLOGY & PARASITOLOGY

111. Studies on pediculosis in goats kept on Vitamin A deficient feeds and restricted activity.

R. P. CHAUDHURI and PAVAN KUMAR, Izatnagar.

Some investigators think that vitamin A supply has a great influence on the pediculosis in animals; others do not agree to this view. It has also been reported that any interference with normal host activity tends to favour pediculosis. In order to study this problem an experiment was carried out to see the effect of vitamin A deficient feeds and lack of exercise on the pediculosis in goats. Four groups of goats of six individuals in the 1st year and ten in the 2nd year, all of the same age and the same breed were taken. One of the groups was having adequate ration with extra vitamin A added and restricted exercise i.e. always confined inside the stall; the second group was having vitamin A deficient ration but normal exercise. The third group of goats was having vitamin A deficient ration and restricted exercise and the fourth group had adequate ration with extra vitamin A added and the normal exercise.

The observation on the lice population on these groups of goats showed that the fourth group was the least infested and the third group the most infested of all. Of the two remaining groups the second was more infested with lice than the first. In other words, the population of lice was more on the goats kept on vitamin A deficient feeds and normal exercise than on those maintained on feeds with sufficient vitamin A supply and restricted exercise.

112. Studies on Biology of *Dictyocaulus filaria* (Metastrongylidae : Nematoda).

V. P. SHARMA DEORANI, Izatnagar.

The adult worms in tap water lived 24-30 hours at room temperature during summer and 2-3 days at room temperature during winter. The best development of the larval stages was achieved in tap water culture, provided adequate measures were taken. In tap water during winter the hatching of the larva took 2-3 days at room temperature and upto 24 hours at room tempertaure during summer. The second stage larva in tap water at room temperature during winter developed in 2-3 days after hatching, and in one day under similar conditions in summer. The third stage larva under similar conditions developed in 1-2 days after second stage in summer and 2-3 days in winter. The ensheathed infective larva was more

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actively motile than the previous stages and was more so in fresh liquid cultures. On the whole, in tap water at room temperature during summer the infective larva developed in 4-7 days after culturing and under similar conditions in 8-11 days during winter.

The first larva failed to hatch out in absence of moisture. Moisture was also essential for further development of the larva throughout the free living stages. The whole process of free living development of larvae was carried out at nearly 30°C. Except infective larvae which could survive at a temperature of 38—40°C for nearly 24—30 hours, the other stages died rapidly. When cultures were kept on ice the development was retarded. The infective larvae lived for 7 days in ice. The egg, first and second stage larvae did not withstand complete dessicataion for more than few minutes. However, the infective larvae possessed a greater ability to withstand it, and on drying they died in 5—30 minutes in summer and 1—2 hours in winter, at room temperature. The first, second and third stages did not migrate for and were not able to cross a height of 0·5 inches. The infective larvae though also showed poor negative geotropism, could cross a height of one inch. The migration of the larvae was generally at night and thus showed some sort of negative phototropism. For migration of the larvae moisture was also found to be essential.

The larvae lived for 1—3 hours in 1 :100,000 copper sulphate solution; ½—1½ hours in 1 :1000 phenyl solution; 1—2 hours in 1 :1000 Dettol solution; and 3—7 days in 1 in 4 faeces and urine culture. The earlier stages of the larva were more adversely affected.

113. Studies on the Biology of *Ogmocotyle indica* (Notocotylidae : Trematoda), Intestinal Trematode of Sheep and Goats.

V. P. SHARMA DEORANI, Izatnagar.

Out of 176 sheep and goats examined 51 were found positive for this infection. In endemic areas, which were generally at an altitude of 6,000 to 8,000 feet, the percentage of infection varied from 44 per cent at Barabaon, 45·4 per cent at Budher, 53·1 per cent at Gwaldam, to 53·8% at Deoban. Number of worms collected from individual cases varied from more than five thousand to more than two lakhs. The ratio of number of eggs voided per gram of host faeces to the number of worms present inside the host averaged 1 :3.

The worms lived 9—17 hours and 10—22 hrs. in water and normal saline respectively at room temperature during winter, and 4—9 hours and 8—14 hours in water and normal saline respectively at room temperature during summer. *In vivo* development of the egg was studied. The rounded eggs first become oval and then a spine like projection first develop at antopercular end. The operculum is demarcated at the other end from which also a spine arises. With the further development, the egg becomes asymmetrically oval and the spines then become unequal long filaments. Attempts to develop the eggs *in vitro* did not result in the development of the miracidia.

For natural infection of *Ogmocotyle indica,* 318 *Euaustenia cassida* and 52 *Limax* from endemic areas were examined, but none was found positive for this infection. Sixty-one clean *E. cassida* which were later fed on *O. indica* eggs, did not take the infection. Out of 397 aquatic snails of the genera *Vivipara. Lymnoea* and *Gyraulus* from the endemic areas examined for natural infection were not found positive for the infection. Twelve clean snails of the genera *Indoplanorbis, Lymnoea* and *Gyraulus* which were fed on *O. indica* eggs also did not pick up the infection.

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114. Life-history studies of *Dictyocaulus Filaria* (Metastrongylidae : Nematoda).

V. P. SHARMA DEORANI, Izatnagar.

The characteristic first stage larva on emergence from the egg was actively motile and measured 0·548—0·582 × 0·019—0·023 mm. The first lethargus began in 12—48 hours after hatching. The second stage larva measured 0·531—0·585 × 0·023 mm. The second lethargus started 12—24 hours after second stage during summer and 24—48 hours during winter. The third stage larva was enclosed in two sheaths and measured 0·514—0·548 × 0·019 mm. The first ecdysis took place in one day's time after third stage, under room temperature in summer and 1—2 days' time during winter. The ensheathed infective larva was characteristic and measured 0·548—0·582 × 0·019 mm.

For studies on parasitic part of the life-cycle, infection was given to guinea-pigs with *D. filaria* infective larva. The unsheathed third stage larvae were found in mesenteric lymph glands from 2—7 days and fourth stage in lungs from third day onwards. In liver no larva was found. On infection by these larvae to kids, they were recovered from intestine upto second day, from mesenteric lymph glands upto 2—3 days and from lungs 7th day onwards. From their liver also no larva was recovered. The unsheathed larvae measured 0·565—0·582 × 0·02—0·023 mm. The fourth stage male larva measured 0·531—0·617 × 0·023—0·026 mm. and female fourth stage larva 0·891—0·943 × 0·030—0·034 mm.

The prepatent period of the infection varied from 39 to 47 days. Cross-infection of *D. filaria* infective larvae from sheep source to goat and from goat source to sheep did not show any significant difference in number of worms developed inside lungs of those hosts.

The results of present study do not support that the prenatal infection takes place in case of this infection. Restricted development of the worms was observed in animals that had previous experience of the infection.

115. On the larval form, hydatid cysts of *Echinococcus granuluosus* (Batsch, 1786) from the Sheep of Delhi State.

L. N. JOHRI, Delhi University.

In course of a survey of helminth parasites from Delhi slaughter houses, the occurrence of the larval form, Hydatid systs of *Echinococcus granulosus* (Batsch, 1786) is reported for the first time from the sheep of Delhi State. Hydatid cysts are available from the lung, liver and the subcutaneous tissues of the sheep. A comparative study of the brood capsules, daughter cysts and the Hydatid sand as available from the different tissues of the host, is undertaken. The percentage of the sessile, stalked and immature forms contained in the daughter cysts (together with stalked and sessile buds) is given in a comparative table. It is ascertained that the lung and liver tissues form the most thriving regions in comparison to the sub-cutaneous tissues in the body of the sheep.

116. New superfamily Orchipedioidea (suborder : Echinostomata Szidat, 1939; order : Echinostomida La Rue, 1957).

H. R. MEHRA, Allahabad.

The family Achillurbainiidae Dollfus, 1939 is dropped. It is synonymous to the family Orchipedidae Skrjabin, 1924. The genus *Achillurbainia* Dollfus, 1939 closely resembles *Orchipedum* Braun, 1901 in the absence of prepharynx, presence of short oesophagus and undulating caeca, pre-equatorial acetabulum slightly

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longer than oral sucker and numerous testes. In *Orchipedum* the latter are entirely post-ovarian and intracaecal but in *Achillurbainia* they are both extra-caecal and intracaecal. Cirrus sac and cirrus are absent and strongly winding vesicula seminalis lies in preacetabular region. Genital pore is median post-bifurcal, ovary is submedian and postacetabular, uterus lies in acetabulo-ovarian zone and eggs are large in both. The vitellaria are composed of numerous small follicles, but they are much more extensive in *Achillurbainia*, where they extend also medianwise interrupted by ovary, shell gland complex, acetabulum and vesicula seminalis. The excretory vesicle is tubular and long. The differences between the genera do not entitle their inclusion in separate families. Orchipedidae contains parasites of bird and mammals and belongs to Orchipedioidea n. supf. Dollfus thinks that *Achillurbainia* shows remote affinity with *Paragonimus* Braun, 1899. Orchipedioidea n. supf. probably stands near Gymnophallid or *Parvatrema* ancestor (Gymnophallidae, Fellodistomatoidea, Fellodistomata) or ancestor of Plagiorchiata as it became evolved from some echinostomid ancestor. Dollfus (1935) traced the development of *Distoma isostoma* (Rud.) into *Orchipedum isostoma* in the nasal fossa of cat *Felis maniculata domest, Mustella vulgaris* and fox *Canis vulpes*.

Diagnosis : Echinostomida; Fellodistomata or Echinostomata, Distomate, unspinate. Acetabulum pre-equatorial, subequal or larger than oral sucker. Prepharynx absent; oesophagus very short or absent; caeca undulating or serpentine terminating near or at end. Genital pore median postbifurcal or preacetabular. Testes divided into numerous follicles. Cirrus sac and cirrus absent. Vesicula seminalis strongly winding, preacetabular. Ovary postacetabular. Receptaculum seminis present. Vitellaria follicular profuse, extending in hind body or greater part of body. Uterus winding, preovarian, intercaecal. Eggs large. Excretory vesicle tubular, long. Cercaria unknown. Metacercaria with Y-shaped excretory vesicle parasitic in Crustacea. Parasitic in birds and mammals. Family Orchipedidae Skrjabin, 1924 syn. Achillurbainiidae Dollfus, 1939.

117. Relationship of suborders Opisthorchiata La Rue, 1957, Reniculata La Rue, 1957, and Plagiorchiata La Rue, 1957 with Echinostomata Szidat, 1939.

H. R. MEHRA, Allahabad.

The position of primary excretory openings of Rhodometopa cercarial embryos of superfamily Renicoloidea (suborder Renicolata) closely resembles that of cercarial embryos of Pleurolophocercous (Opisthorchoid) cercariae. There also exists a basis similarity of the longitudinal membranous fins of the Pleurolophocercous or Ophisthorchoid cercariae to the dorsal and ventral membranous fins of Rhodometopa cercariae. The excretory vesicle is Y-shaped in both these types of cercariae.

The cercariae of *Magapera* (Haploporoidea n. supf.) have also Y-shaped excretory vesicle and develop in rediae. The Echinostomid or Fasciolid cercariae, Pleurolophocercous or Parapleurolophocercous cercariae, Rhodometopa cercariae and of the lage group of Xiphidiocercariae of Plagiorchiata La Rue resemble in having cystogenous gland cells. In all these groups except *Megapera* (Megaperidae) and *Haplosplanchnus* (Haplosplanchnidae) the cercariae possess cephalic (salivary) gland cells. The primitive cercariae of Allocreadiodea Nicoll, 1934 show such close relationship to the Echinostome cercariae that they may be considered to have been evolved from them. The Trichocercous cercariae of *Deropristic inflata* (Cable and Hunninen, 1942) with a long tail possessing a ventral fin fold and six pairs of ventrolateral tubercles each with a delicate hair, posessing eyes, moderately long prepharynx, eight pairs of cephalic gland and cystogenous gland cells is an

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example of such primitive Xiphidiocercariae, which develop in rediae in marine snails.

The above mentioned resemblances of simple tailed cercariae indicate that they may all be considered to belong to the same order Echinostomida La Rue, 1957 syn. Fasciolatoidea Szidat, 1936. Accordingly the orders Renicolida La Rue, 1957, Plagiorchiida La Rue, 1957 and Opisthorchiida La Rue, 1957 have been dropped.

The preacetabular position of genital opening in the adults of these suborders confirms the above conclusion of their affinity and inclusion in the same order Echinostomida La Rue, 1957. The suborders Fellodistomata and Cyclocoelata also show a similarity in the position of their genital pores. The Trichocercous cercariae of Gymnophallidae (*Parvotrema*) show a basic similarity with those of *Megapera, Haplosplanchums* and *Deropristis*.

118. Classification of subclass Digenea Trematoda into orders and of order Echinostomida La Rue, 1957 syn. Fasciolatoidea Zzidat, 1936 into suborders.

H. R. MEHRA, Allahabad.

La Rue (1957) gave a new system of Classification of Digenea. Mehra (1957, 1958) suggested certain modifications. We recognise five orders, Echinostomida La Rue, 1957, Strigeatoidea La Rue, 1926, Azygatoidea Mehra, 1957, Hemiuratoidea Mehra, 1957 and Gorgoderida Mehra, 1958.

1. Order Echinostomida La Rue, 1957 :—Distomate or monostomate with preacetabular genital pore. Cirrus sac typically present but absent in some groups or instead hermaphroditic duct developed with cutaneous copulatory organ cirrus or sucker. Cercariae simple tailed or fork tailed without flame cell groups in tail (Fellodistamata) developing in sporocysts or rediae. Protonephridia monostomate or stenostomate. Miracidia with one pair of flame cells.

2. Order Strigeatoidea La Rue, 1926 :—Distomate or monostomate with genital pore typically postacetabular near or behind the middle body. Cercariae furcocercous, small with flame cell groups in tail developing in sporocysts or rediae. Protonephridia mesostomate or stenostomate. Active penetration into next host. Eggs large. Miracidia with two pairs of flames.

3. Order Azygatoidea Mehra, 1957 :—Distomate or monostomate with acetabulum and without oral suckers. Genital pore preacetabular pre-equatorial near anterior end (*Azygiata* La Rue) or in the middle of anterior margin of tranversely elongated body (*Transversotremata* Mehra). Cirrus sac present or absent. Excretory vesicles Y shaped or V or U shaped. Cercaria furcocystocercous and of gigantic size or monostomate brevifurcate with long furca and tail stem bearing a pair of anteriorly placed arm like appendages arising from basal end of tail and transversely elongated body with pharynx and caeca united posteriorly, developing in rediae. Miracidia with one pair of flame cells.

4. Order Gorgoderida Mehra, 1958 :—Distomate. Genital pore preacetabular near anterior end. Cercariae macrocercous, rhapalocercous or rarely microcercous with simple unforked tail, developing in sporocysts. Cirrus sac absent. Protonephidia mesostomate. Miracidia with one pair of flame cells.

5. Order Hemiuratoidea Mehra, 1957 :—Distomate typically. Genital pore near anterior end. Cirrus sac absent. Cercariae highly specialised, cystophorous or hemiurid developing in redae with flame cell groups in tail. Caudal excretory canal present during development. Excretory vesicle cylindrical or saccate; main collecting vessels fused anteriorly. Protonephridia stenostomate. Miracidia nonciliate but with spinose anterior tip developing in rediae. Second intermediate host a copepod. Miracidia with one pair of flame cells.

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The order Echinostomida La Rue consists of the suborders :—

1. Echinostomata Szidat, 1939.
2. Fellodistomata Singh, 1960.
3. Paramphistomata Szidat, 1939.
4. Cyclocoealata La Rue, 1957.
5. Opisthorchiata La Rue, 1957, amend. Mehra.
6. Reniculata La Rue, 1957.
7. Plagiorchiata La Rue, 1957.

The suborder Fellodistomata has been excluded from the order Strigeatoidea. It consists of families Gymnophallidae Dellfus, 1939, Fellodistomatidae Nicoll, 1913 and Monothelminthidae Dollfus, 1937 (superfamily Fellodistomatoidea La Rue, 1957).

119. Incidence of Males and Females and seasonal fluctuations of Oesophagostomum columbianum (Curtice, 1890) in sheep.

PREMVATI and S. S. LAL, Lucknow.

A total number of 1330 sheep guts was examined during a period of about three years from October 1958 onwards. Practical investigations have revealed that sixty per cent sheep from the local slaughter house are found to be infected with *O. columbianum* and ten per cent with *O. venulosum*. The proportion of female parasites to male parasites is slightly larger, the ratio ranging between 59 :41 and 52 :48. There is a seasonal fluctuation in the incidence of *O. columbianum*. Maximum average infestations were recorded during the months of March and June or July depending on the early or late monsoons; the peak period being reached only in June or July. Lowest incidence was during the months of April and May. Seasonal variations are correlated with temperature and humidity. Another important factor influencing the outside life of *Oesophagostomum* is that sudden change of temperature is seen to retard the hatching of eggs and development of infective larvae. The month of February shows greatest fluctuation in temperature from 17°C to 28°C. During this month the incidence decreases as compared to cold months of December and January.

120. Comparative morphology of *Hæmonchus contortus* (Rudolphi, 1803) Cobbold, 1898, and *Hæmonchus bispinosus* (Molin 1860) Railliet and Henry, 1909 from sheep and goats with a note on the synonymy of *Hæmonchus placei* (Place, 1893) Ransom, 1911 with *H. bispinosus*.

B. N. SAHAI and P. G. DEO, Izatnagar.

In this paper observations on the comparative morphology of the common stomach worms of sheep and goats, namely *Haemonchus contortus* and *H. bispinosus* have been given in detail. The percentage of infection of *H. contortus* and *H. bispinosus* in sheep and goats was found to be 26·8 and 73·2 respectively. *H. bispinosus* has been recorded from sheep and goats in India for the first time. The females of *H. bispinosus* are differentiated from *H. contortus*, an account of the situation of its vulva anterior to the short and stumpy vulvular process. The spicules in the males of *H. bispinosus* are more than 0·44 mm. in length whereas in *H. contortus* they are less than 0·44 mm. Both the species develop in sheep and goats in 28-38 days from the time of ingestion of the infective larvae.

The synonymy of *H. placei* (Place, 1893) Ranson 1911 with *H. bispinosus* (Molin, 1860) Railliet and Henry, 1909 has been discussed in detail.

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121. Studies on the control of Oribatid mites, the intermediate hosts of *Moniezia expansa* (Rudolphi, 1810), Blanchard, 1891.

S. N. SAXENA and P. G. DEO, Izatnagar.

In this paper, the results of the investigations on the efficacy of three acaricides against oribatid mites on pastures are incorporated. The average population of oribatid mites on pastures was found to be highest in the month of August and lowest in the month of January. 40% Nicotine sulphate in the spray solution of 0·2% was found to be 84·4% efficacious against the mites on pastures. 70% D.D.T. in the spray suspension of 0·2% had 88·8% efficacy against the mites, while 25% Lindane in the spray suspension of 0·02% was found to be 92% efficacious against them on pastures. Among the three acaricides tried Lindane was found to be the best in the control of oribatid mites on pasture-land.

122. On a new Trematode from the Redwattled Lapking, *Lobivanellus indicus* (Boddaert).

ATHER H. SIDDIQI and M. SHAMIM JAIRAJPURI, Aligarh.

Four cyclocoeliid trematodes were collected from the air sacs of *Lobivanellus indicus* and were found to be a new species of the genus *Uvitellina*, Witenberg, 1923. The name *U. indica* is proposed. It is 5·683-7·656 long, 1·113-1·536 wide; oral sucker 0·192-0·249 by 0·210-0·326; pharynx subspherical, 0·249-0·345; gonads in an almost one-behind-the-other arrangement, with ovary pretesticular; vitellaria forming a U internal to the cecal arch posteriorly and extending to the level of bifurcation of intestinal ceca anteriorly; eggs numerous, containing ocellate miracidia, 0·136-0·153 by 0·050-0·059.

Skrjabin (1950) recognizes five species of the genus *Uvitellina* and recently Gupta (1958) described a sixth species *U. kaniharensis* from Allahabad. The present species comes closer to *U. pseudocotylea* in body and egg sizes, but differs from it in the topography of the three gonads which form a triangle in the latter species and are almost in linear arrangement in the former. The vitellaria also are internal to the cecal arch in *U. indica* whereas they overlap or are external to cecal arch in *U. pseudocotylea*. It differs from all other species of the genus in having a much smaller body size, extent of the uterus, and topography of the gonads.

(All measurements are in millimeters).

123. Experimental studies on three morphologically indistinguishable species of *Entamoeba*.

WASIM A. SIDDIQUI, Aligarh.

The present study was conducted with the object of discovering : (1) whether *E. histolytica, E. invadens* and *E. moshkovskii* could be adapted to grow at temperatures other than their own optimal temperatures and (2) whether this adaptation is an intrinsic property of the amoebae alone or is influenced by different associates.

DKB, IP and DSR strains of *E. histolytica, E. invadens* and *E. moshkovskii* respectively were used for experiments in a monoxenic condition, with *Clostridium perfringens, C. acidi-urici and Trypanasoma cruzi* as single associates. The experiments were started in each case with an initial inoculum of one million amoebae

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growing at their respective optimal temperatures. The criteria for changing the temperature were first to observe that at a certain temperature the amoebae could survive and secondly that they could multiply. These two steps were taken to be the maker for adaptation of a certain strain with a specific associate at that particular temperature.

In the present study success has been achieved in adapting DKB strain of *E. histolytica* to grow that 30°C and IP strain of *E. invadens* to 35°C with only *C. perfringens* as a living associate. DSR strain of *E. moshkovskii* could also grow at 37°C very easily but it loses its capacity to encyst at the later temperature. The comparison of normal and temperature-adapted strains of the three species of *Entamoeba* with respect to population cycle showed that at higher temperatures the multiplication rate is higher and the population reaches its peak in 2 to 3 days, while at the lower temperature the multiplication rate tends to decrease and the maximum population is reached by the fourth day.

INSTRUMENTS

124. A Spring balance for continuous record of changes in weight of insects under low pressure.

H. L. KUNDU, Pilani.

The construction of a spring balance which can work under low pressure has been described. The balance essentially consists of a cylindrical glass tube inside which is suspended a coiled spring in the free end of which a small insect carrier is attached. The length of the spring directly varies with the weight of the insect. The glass tube with the spring and the insects can be connected with a low pressure system. The weight of the insect at any time and any pressure or humidity can be read off by measuring the length of the spring accurately with certain optical devices which does not necessitate the touching of the apparatus. The instrument is highly sensitive and accurate. The balance was first constructed by Dr. F. Call of the Zoology Department of Imperial College, London for the author, and later reconstructed at Pilani with Indian technicians.

125. An electronic device to detect certain insect pests.

T. A. DAVIS, Calcutta.

Several species of insect pests of the borer type are often difficult to detect at least in the early stages of their attack. The Red palm weevil (*Rhynchophorus ferrugineus*), one of the major pests of the coconut palm is a good example for this. It is the deadliest of the coconut pests since it kills the tree outright by damaging the cabbage, the only growing point. The pest completes its life cycle within the crown of the palm itself. At a fairly late stage, with the drooping of one or two unopened spear leaves, the pest may be detected, but sadly at this stage recovery in most cases is impossible, although very effective pesticides are available. Thus, every year tens of thousands of coconut palms are killed throughout the coconut regions of Asia and the Far East.

For a timely detection of this dangerous pest, a new electronic instrument has been devised. This instrument which is expected to save several palms from the attack of this weevil is of the size of a miniature hand camera and weighs less than 0·5 kg. It is easy to procure (when manufacturing begins), economical to maintain, handy to operate and worked without causing any injury to the palm.

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MORPHOLOGY

126. Kidney disposition in carps.

SURENDER KUMAR AHUJA and MARY CHANDY, Delhi.

The anteriormost part of the mesonephros or the commonly called 'head kidney' in the carp group presents a very interesting disposition. Detailed study of the kidney in *Labeo calbasu, L. gonius, Cirrhina mrigala, Amblypharyngodon mola* and *Rohtee cotio* has revealed that the head kidney consists not only of the lobed structures seen externally but is embedded deep down laterally, so as to have a close association with some parts of the compound vertebra.

Out of all the major carps studied, the head kidney is best developed in *Cirrhina mrigala* where it is even more prominent than the central expanded part of the mesonephros.

Amongst minor carps, *Rohtee cotio* has a well developed head kidney. Its connection with the middle expanded lobe of the mesonephros is peculiar enough to suggest it to be just a reverse condition of what is seen in other carps.

Except for a part of the head kidney that is seen externally in the form of flaps, a large portion of it lies hidden beneath the transverse process of the third compound vertebra in the form of dorsal lobes. Each lobe extends as far as the tripus so as to form a close association with it. The extent of the total coverage of the tripus by the head kidney is variable depending upon its shape and size.

127. On the presence of specialized conducting (connecting) tissue in the heart of the Armadillo.

S. P. BHATNAGAR, Bhopal and O. N. SETH, Vidisha.

The structure and distribution of the specialized conducting tissue of the heart of Armadillo has been studied in serial sections. A well developed kidney shaped sinuatrial node is present in the crista terminalis at the cranial end of the interatrial septum. The sinus venosus is absent. The sinuatrial node is connected with the atrioventricular node through the muscular interatrial septum. A poorly differentiated atrioventricular node is situated in the caudal portion of the interatrial septum. The fibres of A.V. node communicate freely with those of the A.V. bundle and the interatrial septum. The atrioventricular bundle, which is a well developed structure, lies at the cranial extremity of the ventricular septum. It divides into a right and a left branch which extends downwards for a short distance over the respective sides of the ventricular septum. The atrioventricular bundle is connected with the A.V. node by 'Purkinje fibres'. The A.V. bundle is the only connecting tissue between the atria and the ventricles. Multiple muscular connections of Kent are absent. S.A. node, A.V. node and A.V. bundle are all formed of 'Purkinje fibres'. Thus the pathway for the transmission of the cardiac stimulus of contraction is formed of both the ordinary myocardium and the 'Purkinje fibres'.

128. The specialized muscle system and its nervous component in the heart of bats.

S. P. BHATNAGAR, Bhopal.

In the heart of bats the impulse initiating and conducting tissue is formed of sinuatrial node, atrioventricular node, atrioventricular bundle, 'Purkinje fibres', ordinary cardiac muscle fibres and multiple muscular connections of Kent. The heart of bats possess multiple muscular connections of Kent in addition to the

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bundle of His for a quick transmission of the cardiac stimulus of contraction from atria to ventricles. In this feature the heart of bat resembles that of birds and differs from that of mammals. A continuous muscular pathway exists to convey the cardiac stimulus of contraction from one chamber of the heart to the other. The cardiac impulse initiating and conducting tissue of birds and mammals develops in accordance with the functional requirements of the heart of individual animals. The nervous component of the specialized muscle system as seen in the heart of bat has been described. The nerves and ganglia were observed in the atrial walls and in the vicinity of sinuatrial and atrioventricular nodes. The nerve supply to these nodes has been described.

129. "Bulbus" and "Conus" in the heart of Clupeiformes.

ASIT BARAN DAS, Gorakhpur.

The transition from the selachian muscular, contractile "Conus Arteriosus" to the teleostean non-muscular non-contractile, elastic "Bulbus Arteriosus" is not an abrupt one. Intermediate conditions of the conus, with more than two valves, have been described in Polypteriformes, Acipenseriformes, Amiiformes, Lepidosteiformes and in many lower Teleosts (Clupeiformes). The present account adds to the above list three more fishes from different families of the order Clupeiformes. In *Chirocentrus dorab* (Forsk.) of the family Chirocentridae three conical pocket-shaped valves in a circle have been found in the conus. The same condition in the conus has been observed in *Hilsa ilisha* (Ham.) of the family Clupeidae. In *Notopterus chitala* (Ham.) of the family Notopteridae four ventriculo-bulbular valves have been reckoned, which are arranged in two horizontal tiers, representing two longitudinal rows. However, in *Gudusia chapra* (Ham.) of the family Clupeidae, a typical teleostean condition has been observed in the conus, with only two valves. The shape of the bulbus arteriosus in these fishes ranges from a long tubular type in *Chirocentrus* and *Notopterus* to a short globular type in *Hilsa* and *Gudusia*. The internal surface of the bulbus is trabeculate in *Hilsa* and *Gudusia*, incipiently ridged in *Chirocentrus* and smooth in *Notopterus*.

130. Correlative Histological Changes in the Bursa of Fabricius and the Gonads of the Domestic Pigeon, *Columba livia* Gmelin.

C. J. DOMINIC, Varanasi.

The correlative histological changes in the bursa of Fabricius and the gonads of *Columba livia* have been studied from hatching to sexual maturity. At the time of hatching, when the testes contain only primordial germ cells and spermatogonia, and the ovary only the oogonia, the bursa of Fabricius is already fully developed. The cortex and the medulla of the follicles of the bursa are well defined ; mitosis of the endodermal epithelial cells and of lymphocytes are common. Interfollicular connective tissue of the bursa is thin. At about three months of age, the bursa of Fabricius attains its maximum development. There is a slight increase in the interfollicular connective tissue. When the gonads begin to grow and the bird prepares for breeding, the bursa begins to show signs of involution. It shrinks in size and the lymphocytes in the follicles turn pycnotic and gradually disappear and the remaining epithelial cells reconstitute themselves into epithelial buds. Some of the follicles undergo cystic degeneration simultaneously. When the birds reach the peak of reproductive activity, with bundles of spermatozoa in the seminiferous tubules of the testes and fully grown ova in the ovary, the bursa completes its regression and is represented by a rudiment on the dorsal side of the cloaca, which

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is composed of connective tissue and a few capillaries. This also disappears after the first breeding season and no trace of the bursa is left behind on the cloaca in adult birds. It is evident that there is a causal relationship between sexual maturity and the bursa of Fabricius in birds. It is suggested that the sex hormones have an antagonistic effect on the bursa of Fabricius. This assumption is further supported by experimental work, where the injection of steroids brings about the premature involution of the bursa in sexually immature birds.

131. The Ovary of the Domestic Pigeon, *Columba livia* with Special Reference to Follicular Atresia.

C. J. DOMINIC, Varanasi.

The ovary of the domestic pigeon, *Columba livia* Gmelin is studied with special references to the atretic follicles. Because of their high frequency of occurrence, the atretic follicles are to be regarded as a normal feature in the ovary of this bird. The follicular atresia shows much variation depending on the stage of growth of the ova and also on the phase of the reproductive cycle. The atretic follicles can be classified into (a) the *bursting* type, (b) the *in situ* type, and (c) *cysts*. The bursting atresia is more common during the progressive, reproductive and regressive phases of the ovarian cycle. Cystic degeneration of the follicles is of very rare occurrence. During bursting atresia, the ovular debris is discharged into the ovarian stroma or into the body cavity after the rupture of the theca. In the *in situ* type, the ovular debris is resorbed *in situ* without the rupture of the thecal wall. The bursting atresia is seen more frequently in the case of the larger follicles, whereas the *in situ* type of atresia is the rule in the younger follicles. The ovular debris is eliminated during atresia by phagocytes which are of granulosa origin. Occasionally stromal cells also act as phagocytes. The theca interna cells do not play any role in phagocytosis. The phagocytes fill the lumen of the atretic follicle by hypertrophy; mitotic or amitotic division is not observed. Pigment formation is not common in the atretic follicles of the pigeon.

The dissolution of the unused ova, after breeding season, is intended for the restitution and rehabilitation of the ovary as well as for lightening the ovary of an unnecessary charge. The occurrence of atresia in the ovaries of nestlings is probably due to a genic imbalance of the oogonia. The significance of the atretic follicles in birds is not properly understood. It is probable that the progestin necessary for inducing ovulation is elaborated in the atretic follicles and thus these structures may be playing some kind of endocrinal role in birds and other oviparous vertebrates.

132. The specialized conducting system of the heart of 31 mm. embryo of *Hemidactylus flaviviridis*.

RAJ KUMAR GAUR, Bhopal.

The heart of 31 mm. embryo of *Hemidactylus flavivirids* has been studied in serial sections and its conducting system has been described. The specialized conducting structures of the heart of this embryo are a sinuatrial node and an atrioventricular plug. A well developed sinuatrial node is present very near to the sinuatrial opening and communicates freely with the sinuatrial valves and the interatrial septum. An atrioventricular node could not be observed. It is pointed out that the development of the conducting system of the heart of Hemidactylus should be completely worked out before denying the presence of atrioventricular node. An atrioventricular plug has been observed to lie just above the atrioventri-

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cular opening. It is a narrow U-shaped structure and its two limbs join the base of atrioventricular valves and become continuous with them. The contraction stimulus originating at the sinuatrial node would be conveyed to the atria through the sinuatrial valves and the interatrial septum. This impulse would be transmitted to the atrioventricular plug through ordinary muscle fibres of interatrial septum and would be distributed to the ventricles by the two limbs of the plug after a necessary pause. The phylogeny of the impulse conducting structures of the heart of reptiles, birds and mammals has been discussed.

133. Studies on the Weberian appratus and related structures of Indian Ostariophysi. Part III. The evolutionary significance.

C. L. MAHAJAN and MEENA KUNCHAL, Muzaffarnagar.

The paper records the differences between the lower and higher cyprinids in the structure of the Weberian ossicles. The study shows how these differences might be used to determine the evolutionary status of a given species. It has been found that in general the Weberian apparatus in lower cyprinids shows a lesser degree of fusion between various elements constituting it. Moreover the ossicles forming the chain connecting the air bladder with the internal ear seem to be lighter and less solidly built in lower forms as compared to higher forms. The length of tripus in particular and that of chain in general as compared to total length of fish provides another useful index to determine the place of a given species in the natural classification of the group.

134. Studies on the Weberian apparatus and related structures of Indian Ostariophysi. Part IV. Taxonomic value with reference to the genus *Labeo* (Cuvier).

C. L. MAHAJAN and MEENA KUNCHAL, Muzaffarnagar.

This is a more intensive study of the Weberian apparatus and indicates how a comparative study of this apparatus might be used as an important taxonomic character. Three species of *Labeo* (Cuvier) were examined for this purpose and sufficiently distinctive characters were found to differentiate one species from another. These differences are describd in detail and the value of the apparatus as a systematic tool has been emphasized. The importance of such a study, specially to classify rare and fossil fishes can hardly be overestimated in view of the facts presented.

135. On the blood supply of the pecten of cattle egret, *Bubulcus ibis*.

P. N. MEHROTRA, Ranchi.

The pecten of cattle egret is mainly composed of blood vessels and capillaries composed of a single layer of atypical endothelial cells whose cell boundaries are indistinct. The cytoplasm is swollen into a structureless clear homogenous mass in which large and oval nuclei are interspersed. Each of the nuclei contains prominent nucleolus. The main artery supplying the pecten lies near the upper part of the pecten and divides into several branches, each supplying one fold of the pecten. Venules come from each fold of the pecten and join to form a main vein which runs side by side with the main artery.

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136. On the structure of the pecten of cattle egret, *'Bubulcus ibis'*.

P. N. MEHROTRA and P. B. SINHA, Ranchi.

The pecten of birds still presents problems which are obscure. The histology of the pecten is best seen in 2-3 μ sections of bleached material. The pecten of the cattle egret is mainly composed of small capillaries composed of a single layer of atypical endothelial cells whose cell boundaries are not distinct. Outside this is a perfectly clear hyaline limiting membrane completely investing each capillary. This membrane does not stain and stands out very sharply as a perfectly clear shining line. The capillaries contain nucleated oval blood cells. In between the capillaries can be seen small cells, occasionally stellate though generally round, each with a round, deeply staining and centrally situated nucleus. The cytoplasm is loaded with pigment granules, a single cell containing 50—100 spherical granules of varying sizes. One or many of these cells may lie between two capillaries. The black colour of the pecten is due to these pigment cells. We have been unable to confirm Franz's observations of sensory hairs and end bulbs in the pecten.

The authors do not agree with the view that the pecten is a portion of the choroid coat which has passed through the foetal fissure and proliferated inside the eye. The blood supply of the pecten is connected with the vessels in the optic nerve and not with the choroidal vessel. Further the structure of the pecten is different from the choroid. The choroidal vessels are much larger. Their walls are lined with flattened endothelium and are sometimes more than one cell thick. The cytoplasm lacks the curious swollen appearance of the cytoplasm in the endothelial cells of the pecten. Moreover the capillaries of the choroid lack a hyaline limiting membrane. The pigment granules in the choroid are much smaller but are present in such large numbers that they completely hide the nucleus.

137. On the passage of spermatozoa from the testis tubules.

P. N. MEHROTRA, Ranchi.

The mechanism responsible for the passage of spermatozoa from the seminiferous tubules to the epididymis and onward is not fully understood. Oslund ('28) has suggested that the continuous production of secretion in the seminiferous tubules is sufficient to maintain the current in which the sperms are directed forwards towards the vas deferens. Young ('31) believes that the distally directed current of spermatozoa is maintained in part by the secretion of the seminiferous tubules and in part by the cilia present in the vasa efferentia. Bailey has remarked that the capillary force of the epididymal tubules is one of the factors which direct the passage of sperms.

It was observed that just before the onset of the reproductive season in *Anser anser* and *Copsychus saularis* there is a marked development of connective tissue fibres in the intertubular spaces and around the seminiferous tubules. I, therefore, believe that the contraction of seminiferous tubules brought about by the elastic connective tissue fibres is also an important factor responsible for the movement of sperms in the birds, from their place of production to the vas deferens, in addition to other factors suggested by Oslund, Young and Bailey.

138. Studies on the Urinogenital System of some Marine Teleosts. Part I.

V. B. NADKARNI, Dharwar.

The urinogenital system of eleven species of marine teleosts i.e. *Therapon jarbua, Gerres lucidus, Scatophagus argus, Teuthis oramin, Caranx crumenophthalmus, Equula daura, Sillago sihama, Platycephalus insidiator, Trichiurus*

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haumela, Belone strongylurus and *Chirocentrus dorab* is described. The kidneys are paired, elongated bodies generally fused for a part or whole of their length. In *Belone strongylurus* an isolated head kidney is present on the left side, but, on the right side, the head and the trunk kidney are continuous. An isolated piece of trunk kidney is present in *Scatophagus argus* and *Teuthis oramin* posteriorly. The urinary bladder of *Sillago sihama* passes through the wall of the air bladder which is a unique feature. The urinary pore is independent in all the females studied and also in the males of *Platycephalus insidiator* and *Trichiurus haumela*. There is a common urinogenital pore in the remaining male fishes. Abdominal pores are reported in three female fishes. A slit like integumentary cloaca is found in seven of the eleven species studied.

139. Studies on the Urinogenital System of some Marine Telcosts. Part II.

V. B. NADKARNI, Dharwar.

The urinogenital system of *Rastrelliger kanagurta, Cybium guttatum, Stromateus niger, Pseudorhombus arsius, Synaptura orientalis, Arius platystomus, Chatoessus nasus, Tricanthus strigilifer* and *Tetrodon lunaris* is described. In *Tricanthus strigilifer* and *Tetrodon lunaris* the paired kidneys are short, separate and placed anteriorly in the body cavity. The head kidney in *Arius platystomus* is completely separate from the trunk kidney. The paired mesonephric ducts are generally embedded in the kidney. The urinary bladder is thin walled except in *Cybium guttatum, Arius platystomus* and *Tetrodon lunaris,* where it is thick walled. The urinary pore is independent in all the female species studied and also in the male *Tetrodon lunaris.* There is a common urinogenital pore in the remaining eight male species. The urinary pore in *Pseudorhombus arsius* and *Synaptura orientalis* is placed on the coloured side of the body. Abdominal pores are found in three species, in both the sexes. An integumentary cloaca is reported in five species. In the remaining four species the external openings are placed directly on the body surface.

140. Studies on the pronephros of *Cirrhina marigla* (Hamilton).

V. B. NADKARNI, Dharwar.

The paper deals with the structure and the degeneration of the pronephros in *Cirrhina mrigala,* a major Indian carp. The earliest stage that could be available for the study was the free swimming larva measuring 6 mm. in total length. At 6 mm. stage the pronephros of *C. mrigala* is fully formed. It reaches its functional peak at 10 mm. stage. The stages between 11 mm. to 15 mm. may be regarded as transitional stages when the functional pronephros becomes non-functional. The pronephric corpuscle becomes isolated from the pronephric tubules and the lymphoidal tissue and is progressively reduced in size. It is not absorbed by the pronephric lymphoidal tissue. The degeneration of the pronephric tubules is a slow process when compared to that of the pronephric glomerulus.

141. On the specialized conducting tissue of the heart of *Varanus monitor*.

RAVI PRAKASH and RAJENDRA SAHAI, Betul.

The impulse conducting tissue of the heart of *varanus monitor* has been described. The sinuatrial node has two distinct components. It has been argued that 'U' shaped sinuatrial node of mammals has evolved by the fusion of the two

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components of the sinuatrial node of reptilian heart. The atrioventricular bundle is present at the posterodorsal margin of the interatrial septum. A connecting muscular pathway has been observed to show that the cardiac stimulus of contraction which would originate at the sinuatrial node would be conveyed to the interatrial septum through the cephalic sinuatrial valve and from the interatrial septum to the atrioventricular bundle and then to both the ventricles. Ordinary muscle fibres as well as Purkinje fibres form the pathway for the conduction of the cardiac stimulus of contraction. The observaitons support the myogenic theory of impulse initiation and conduction.

142. Innervation of the heart of the shrew, *Suncus murinus*.

RAVI PRAKASH and R. C. HARITWAL, Betul.

The nerves that supply the heart and the blood vessels in the shrew, *Suncus murinus* have been examined through dissection of the animals as well as in the serial sections of the heart stained by Peters method. Contrary to the findings of many others the cardiac plexus has been observed to be single and indivisible. Small intrinsic and extrinsic ganglia were also observed. Most of the nerves present in and around the heart run parallel to the main blood vessels. The specialized conducting tissues is also profusely supplied with nerve fibres. The atria are very rich in nerve supply but the ventricles are poorly innervated. The dorsal portion of each ventricle has more nerves than the ventral portion. The present study not only confirms the presence of a specialized muscular conducting tissue in the heart of birds and mammals but it also points out that this muscular conducting tissue is richly innervated.

143. Specialised conducting system in the heart of Indian Gharial, *siGava gangeticus* (Gray).

JAGDISH PRASAD, Beawar.

A complete and adequate conducting system comprising of the structures, Sinuatrial node, atrioventricular node and atrioventricular bundle in the heart of *Gavalis gangeticus* has been observed and described for the first time in Loricata. Histologically specialized structures initiate, control and conduct the cardiac stimulus of contraction. They attribute an impressive bearing on the phylogeney of the impulse conducting tissue of the heart of birds and mammals. *Septum ventriculorium* is unique and contradistinctive. Divergent pathways for the conduction of contraction impulse from sinuatrial node to right atrium exist. One way is through the sinus venosus and the right sinuatrial valve similar to that of Fishes and Amphibians (anaminiata) and the other direct through left sinuatrial valve resembling Birds and Mammals (amniota).

144. Functional development of the accessory respiratory organs in air-breathing fishes in relation to the modification of the swimbladder.

S. Z. QASIM, Aligarh.

Beside performing the function of breathing atmospheric air the accessory respiratory organs like any other gas filled space are also concerned with the perception of hydrostatic pressure. When the air breathing fishes are subjected to change in pressure, the volume of air contained in the accessory respiratory organs is controlled. At increased pressure the gas in the respiratory organs is retained and when the pressure is decreased the gas from these organs is expelled.

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In this way the fishes are able to regulate their buoyancy by swallowing and releasing air from the accessory respiratory organs. Such a hydrostatic function of the accessory respiratory organs recalls similarities between these organs and a physostomatous swimbladder, for in this type of swimbladder also the density regulation of the fish occurs in a similar way.

There exists a correlation between the development of the accessory respiratory organs and the modification of the swimbladder. Fishes possessing a well developed physoclistic type of swimbladder such as *Ophicephalus* have primitive pharyngeal type of accessory respiratory organs. But in fishes like *Heteropneustes* and *Clarias* where the swimbladder has become reduced and non-functional the accessory respiratory organs have become enlarged and highly modified. Presumably the greater development of accessory respiratory organs is an adaptation to compensate for the hydrostatic function of the swimbladder.

145. On the morphology, extrinsic muscles and anatomy of Tongue of garden lizard, *Calotes versicolor*.

R. SAHAI, Raipur.

Morphology, muscles, and minute anatomy of the tongue of garden lizard *Calotes versicolor* has been studied and described. The morphology and anatomy of tongue varies in the apical region, middle and at the root. The extrinsic muscle system is well developed. The position of Geniohyoid, Stylohpoid, Genioglossus and Hyoglossus muscles has been described in relation to the Hyoid apparatus. Mucus glands are sparsely distributed all over the tongue. Lingual glands are paired and posterodorsal in position. Taste buds are absent and only filiform papillae could be located.

146. On the specific differences in the cranial morphology of the two allied species, *Mystus (Osteobagrus) seenghala* (Sykes) and *Mystus (Osteobagrus) nor* (Hamilton).

H. L. SARKAR, Delhi.

An attempt has been made in this paper to find out some dependable osteological characters for differentiating the two allied species, *Mystus (Osteobagrus) seenghala* (Sykes) and *Mystus (Osteobagrus) aor* (Hamilton) of the sub-genus *Osteobagrus*. As the cranium of fishes show the stable characters, the adult skulls of the two species, viz., *seenghala* and *aor*, having nearly the same standard length, were taken for the study. After examining the cranium, the most striking points of difference between the two species are tabulated :

	Mystus (Osteobagrus) aor	*Mystus (Osteobagrus) seenghala.*
1.	Skull is massive and broad.	Skull is slender and narrow.
2.	Dorsal side of the skull is deeply sculptured and pitted.	Dorsal side of the skull is not prominently sculptured.
3.	Posterior fontanelle is very small and slit like.	Both the fontanelles are prominent and wide.
4.	Supraoccipital process is very strong, long and narrow at the base.	Supraoccipital process is not strong, short and broad at the base.
5.	Space between the antero lateral processes of supraethmoid is small and is one third the distance between the ends.	Space between the antero lateral processes of supraethmoid is wide and is half the distance between the ends.

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	Mystus (Osteobagrus) aor	*Mystus (Osteobagrus) seenghala*
6.	Anterior portion of the supraethmoid projects out considerably after the vomer.	Anterior portion of the supraethmoid projects very slightly after the vomer.
7.	Ledge of the parasphenoid is wide, short and extends upto the middle of the frontal ventrally.	Ledge of the parasphenoid is narrow, long and extends to the posterior end of the ectoethmoid ventrally.

On the strength of the analysis of the different osteological characters, it is concluded that *seenghala* and *aor* are two widely separated species.

147. Digestive System of *Scolopendra mersitans* Linn.

G. S. SHUKLA, Gorakhpur.

The alimentary canal is a straight tube extending from the mouth to the anus. The mouth lies on the ventral side of the head. The preoral cavity is bounded by the mouth parts; the hypopharynx divides it into food meatus and salivary meatus. The dorsal part of the food meatus is the cibarium in which opens the mouth. The salivarium lies at the base of the salivary meatus, in which lies the opening of the salivary ducts. The foregut is divisible into the buccal cavity, pharynx, oesophagus, proventriculus and stomodaeal sphincter. The midgut extends from the 14th to the 18th segments. The hindgut opens outside through the anus, and its anterior end has two long slender Malpighian tubules. The salivary glands are paired and mulberry shaped.

The wall of the foregut has a layer of circular muscles on the outside of which are found a few bundles of longitudinal muscles while on the inner side a layer of longitudinal muscles. The epithelium is thin, thrown into folds, and is lined by a thick chitinous intima. In the proventriculus the wall has a thick layer of circular muscles. The midgut does not show chitinous intima while hindgut has a thin layer of chitinous intima.

These animals can feed on various kinds of insects, their larvae, and earthworms but they can take milk and tea and fleshy fruits as well.

148. Presence of Melanoblasts in the testis of some Indian birds.

P. D. TEWARY and R. N. SAXENA, Varanasi.

The presence of dark coloured testis is not uncommon in the birds. During the course of study in certain Indian birds, we found quite a number of them possessing both or one (generally left) testis coloured dark brown or black. This characteristic colouration is due to the presence of melanoblasts in the fibrous connective tissues of the interstitium. A variation in the intensity of the colour (pigment) was also noted which corresponds with the sexual cycle of the animal. During non-breeding season and in juveniles when the testis size is minimum and there is no spermatogenesis, the colour is intense, but as the breeding season approaches, the testis starts increasing then pigmentation decreases and at the peak of the breeding season, when the volume of the testis is maximum, the dark colour has practically vanished. The gonad now appears yellowish white in colour. After the breeding when the testis has become small in size, pigmentation again appears. The reason of this cyclic changes in the pigmentation that follows testis size cycle, may be that, during eclipse the melanoblasts get concentrated in a smaller area of the testis, thus pronouncing their effect, but in the nuptial phase, when the testis enlarges the melanoblastsare dispersed over a larger area resulting in an apparently non-pigmented testis.

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It seems, therefore, that this colour variation may be due to changes in the testis volume during the sexual and non-sexual phases resulting in the despersal or concentration of the melanoblasts. Percentage of pigmented testes in the birds studied is :

Rosy starling (*Pastor roseus*) 14%
Pied mynah (*Sturnopastor contra*) 17%
Bank mynah (*Acridotheres ginginianus*) 13%
Black-headed mynah (*Temenuchus pagedarum*) 13%
Common mynah (*Acridotheres tristic*) 7%
Spotted munia (*Uroloncha punctulata*) 10%
White-throated munia (*Uroloncha malabarica*) 5%
Red headed bunting (*Emberiza brunniceps*) 10%
The role of these pigmented cells inside the gonad is not fully understood.

149. The conducting system in the heart of 70 m.m. embryo of redvented Bulbul, *Molpastes cafer* (Linn.).

KM. NAJMA YOUSUF, Bhopal.

The conducting system in the hearts of six 70 m.m. embryos of Redvented Bulbul has been studied in serial sections. It is observed that sinus venosus is getting incorporated into the right atrium. A well developed sinuatrial node is present near the cranial end of the interatrial septum and the opening of post caval vein into the sinus venosus. The shifting of sinuatrial node away from the sinuatrial opening has been regarded as due to the structure and disposition of the sinus venosus. The atrioventricular node is a well developed structure situated near the caudal portion of interatrial septum. 'Purkinje fibres' were not observed in the wall of atria or in interatrial septum. The two nodes are connected with each other through ordinary myocardium of I.A.S. A well defined saddle shaped atrioventricular bundle was observed at the top of the ventricular septum. The A. V. Bundle bifurcates caudally into a right and a left branch which reach the base of atrioventricular valve of its side. No multiple muscular atrioventricular connections in addition to bundle of His were observed. Several nerves and ganglia were found at the atrioventricular junction and in the nodal regions.

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SECTION OF ANTHROPOLOGY AND ARCHAEOLOGY

President :—DR. S. C. SINHA

Abstracts.

I. PREHISTORIC ARCHAEOLOGY

1. Microlithic Industry from North-West Midnapur, West Bengal.

ASOK KUMAR GHOSH, Calcutta.

The paper deals with the microlithic industry of Bhararu, two miles north-east of Silda, north-west Midnapur. This part embraces a portion of the eastern fringe of the Chota Nagpur plateau. The site is located on a high ridge of mica-schist, grey or bluish-grey in colour with bands of gneissose character. The mica-schist is overlain by pisolitic laterite in certain places. The microliths along with cores and waste flakes were found as surface finds on the laterite. It appears that the microliths have come out from pisolitic laterite by erosion and water action. The materials used for the microliths are white quartz, black quartz with white stringers and cherty quartzite which locally occur in the form of veins in the hard quartzites in the neighbourhood.

The site yielded a good number of microliths and associated cores and waste flakes. The microliths include blades, scrapers, points, awls and pseudo-burins. The industry appears to be very primitive as evidence from the crudity of technique and absence of evolved types. Typologically it recalls the microlithic industries of adjacent districts of Singbhum and Manbhum.

2. Stone Age vestiges in and around Badami (Mysore).

K. V. SOUNDARA RAJAN, Baroda.

The paper summaries the obseravtions of the author on the collection of Early Palaeolithic and Late Palaeolithic tools he had made in the vicinity of Badami in the autum of 1960. The context of the Early Palaeolithic tools on quartzite picked from Badami town and its environs, to some extent compares, broadly speaking, with the similar but more typical tools observed in the detrital lateritic coastal high ground north of Madras around the Red Hills area.

The rest of the collections of medium to small size tools picked up from the neighbourhood of Sitalphadi cave in the uppermost rocky terrace, on the other hand, shares many comparable features with Late Palaeolithic tools elsewhere but show evolution over the typical Middle Stone Age Industries and, at the same time, only anticipate but not participate in the truly microlithic *mileau*. A few specimens and types of this collection are indeed of the microlithic and perhaps show the overlap of the later development. The collection could well be called 'proto-microlithic'.

The nature of the cave remains and the artefact remains indicates fruitful possibilities if further detailed work is undertaken in the region.

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3. Microlithic industries from Adamgarh rock shelters near Hoshangabad, Madhya Pradesh.

R. V. JOSHI and M. D. KHARE, Nagpur.

The occurrence of microliths near the Adamgarh rock shelters is known since long. In the last winter the authors carried out excavations in the rock-shelters and in the open ground adjacent to them. Nearly 18 trenches were taken each one of which yielded a large number of microliths. The associated deposit was black clay or silty clay which was either resting directly on the local quartzite rock or lying with a marked erosional disconformity over the red lateritic clay. No soil profile was seen anywhere on the top of this hill.

The microlith-bearing deposit seems to have been derived from the adjoining black cotton soil plain (terrace) of the Narmada by wind action.

The tools assemblage consists of crescents, various points, blades, and scrapers, a few burins all made on chalcedony and allied siliceous material. The raw material seem to have been brought from the neighbouring Narmada river bed. The occurrence of huge quantity of raw material, cores and unfinished tools in association with the finished implements suggests that this was a factory site.

The microliths were found in all the levels of the black deposit and it appears that the formation of this deposit was contemporaneous with the microlithic settlements of the Adamgarh hill.

4. Excavations at the Palaeolithic site on the Adamgarh hill near Hoshangabad, Madhya Pradesh.

R. V. JOSHI and M. D. KHARE, Nagpur.

In 1935, de Terra collected a few palaeoliths from the laterite pockets on the Adamgarh hill in the vicinity of the rock-shelters. They comprised of Abbevillian-like handaxes and pebble choppers with no Acheulian artefact. In the subsequent explorations at this site several artefact wre obtained from the surface deposits.

With a view to find the definite source of these tools and to know the characters of the implementiferous deposit the excavations were carried out in the rock-shelters as well as in the adjacent level surface on the Adamgarh hill. A large trench approximately in the centre of this hill yielded nearly 150 implements. These were recovered from the rubble bed which was mixed up with the red laterite clay. Underlying this tool-bearing horizon was the hard gravely laterite resting on the rock.

The majority of the tools were stained red due to associated lateritic clay. The collection comprised of handaxes, cleavers, choppers, cores, flakes and flake scrapers with a dominant Acheulian characters. On the north-east slope of this hill a naturally exposed section showed highly weathered quartzite rock overlain by ferruginous (lateritic) hard crust. On it were resting in successive order laterite, disintegrated laterite (pisolitic laterite gravel) red clay and the stone rubble. The stages of lateritization of the quartzite and sandstone of this hill could very well be noticed here.

This implimentiferous clay deposit is comparable to the red concretionary silty clay of the Lower Group of the Narmada Pleistocene deposits.

5. On the Occurrence of Quartzite-flakes in the Neolithic deposits at Nagarjunakonda.

H. SARKAR, Guntur.

In the excavation at Nagarjunakonda a large number of flakes and blade-like flakes of quartzite were found in the neolithic levels in association with neoliths

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of dolerite, microliths of chert and prismatic quartz-crystal, besides pottery, beads of shell, paste and steatite and other miscellaneous stone objects like pestle etc. In the majority of cases, these flakes are not secondarily worked into any standard tools, nor do they seem to be waste material of neolithic tool manufacture, as no neolith on quartzite was obtained in the Nagarjunakonda valley. In addition to these quartzite flakes, others of dolerite were also discovered, but since all the neolithic tools are of dolerite, the existence of dolerite flakes can be understood.

These quartzite flakes, in all likelihood, were utilized by the neolithic settlers of Nagarjunakonda in their daily requirements, which normally could not have been met with by neolithic tools proper or by microliths.

6. Megalithic Human Remains excavated at Yelleswaram (Andhra Pradesh).

PABITRA GUPTA and PRATAP CHANDRA DUTTA, Calcutta.

Through the courtesy of the Director of State Archaeology Department, Hyderabad, during April, 1961, the writers had the privilege of examining the megalithic human skeletons excavated at Yelleswaram which is situated on the left bank of river Krishna, opposite to the ancient site of Nagarjunakonda.

Five crania, of which three are males and two females, and a few long bones were studied. Only two crania are better preserved and are in somewhat complete form. The skulls are massive, rugged and the bones are thick. Of the three male skulls one is hyperbrachycranic and two are brachycranic, while among the females one is mesocranic. The skulls are euencephalic in cranial capacity. Applying Dupertuis and Hadden's as well as Pearson's formulae stature is estimated to be tall.

In a recent publication Dr. S. S. Sarkar has reported the presence of similar brachycranial and mesocranial skulls from the megaliths of Brahmagiri, Mysore. He postulates that these brachycephals were foreign in origin and he traces affinity with the Sialk megalith builders. This hypothesis may further be confirmed on publication of report on Nagarjunakonda megalithic skeletons.

II. PHYSICAL ANTHROPOLOGY

7. Human Crania from the Historical Site at Ujjain.

PABITRA GUPTA, ARABINDA BASU and ANIMA RAY, Calcutta.

At the historical site of Ujjain human crania were unearthed during May, 1939 from a high mound at Kumhar Tekri. In this paper report on 18 better preserved skulls have been presented, of which 12 are male and the rest are female.

The crania are dolichocranial, orthocranic, euryprosopic and chamaerrhine. Morphologically, foreheads are slightly arched with moderate parietal eminence, moderately projecting occiput with moderate mid-facial width and medium to broad nasal aperture.

It is a point of interest that sexual dimorphism is reflected only in dimensions and not in proportions.

The series is not very divergent and in conformity with the existing population of Northern India. In the typyal sense Ujjain crania agree fairly well with the Punjabi and Rajput skulls.

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8. Preliminary Study on the Hair Characters of the Australian Aborigines (Western Australia).

A. R. BANERJEE, Calcutta.

A study of 48 hair samples (male—17; female—31) from the Australian aborigines from western Australia were undertaken for the following: form, colour, texture, hair length, medullation, and hair diameter. It has been found that in males flat, broad, and narrow wavy hair occurs in equal frequqencies, while in females, broad wavy hair occurs in the highest frequency. The incidence of medullated hair is higher in both the sexes (male—68·47%; female—52·64%) than the non-medullated type (male—31·53%; female—47·36%). Among the Australoid tribes of India the medullated hair has been found in the frequency of 68·08% and 74·59% in males and females reespectively. The male hair is thicker ($97{\cdot}63 \pm 0{\cdot}83\mu$) in diameter than the female ($82{\cdot}37 \pm 0{\cdot}61\mu$). The hair diameter of the male Australoids has been found to be $97{\cdot}04 \pm 0{\cdot}94\mu$ while that of the female $89{\cdot}28 \pm 1{\cdot}33\mu$.

9. Ethnic affinities of Rajputs of Pauri Garhwal (U.P.).

R. K. GULATI, Poona.

Somatometric measurements and somatoscopic observations were taken on 86 male Rajputs called Khasiyas of Pauri Garhwal (formerly British Garhwal) in 1956. The Garhwali Rajputs are a heterogeneous group as indicated by different somatometric and somatoscopic characters. Even the great range of variation in majority of the characters supports this.

The Garhwali Rajputs are akin to rest of the Cis-Himalayan people e.g. Brahmins, Rajputs and Artisan of Jaunsar, Kanets of Kulu; Brahmins, Rajputs and Doms of Almora etc. with respect to stature, cephalic index and nasal index. But with respect to stature and nasal index they seem to be akin to the preponderantly Mongoloid human group of Nepal and Eastern Himalayas and Bhotiyas of Almora on the one hand while the high castes of Almora, Baghel Rajputs (U.P.) and Gwala of Bihar on the other hand. However, the predominant element among these people is medium stature and dolicho heads, in association with lepto to mesorrhine nose. The Brachycephalic heads are present in 3·48% of the cases. The Somatoscopic characters like skin colour, hair form, eye colour, and other such characters indicate that Garhwali Rajputs are a mixed group. The 'test of significance' also shows the closest possible similarity with Doms, Kasa Rajputs of Almora and Rajis of Almora. The value of co-efficient of variation is above 4 for 25 out of 32 characters which clearly show that they are highly mixed.

10. The Anthropometry of the Lambadi Males.

PABITRA GUPTA and ARABINDA BASU, Calcutta.

The Lambadi, a seminomadic tribe of Southern and Western India, trace their origin from the Rajput. Anthropometric data were collected during January—April, 1960 from two districts of Andhra. They speak a corrupt form of Hindusthani and Marwari. Historical records and linguistic evidences point their origin from Northern India particularly Rajputana.

In physical appearance, they are medium to below medium in stature, mesocephalic and hypsicephalic in head, mesorrhine in nose, and mesoprosop and euryprosop in face. They are relatively fair complexioned.

Comparison has been instituted with different Rajput groups and it is observed that in many characters they agree with the Rajput while in others they differ.

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These divergences might be due to mixture with other populations and segregation from the original people from whom they trace their origin.

11. Bengal Kayasthas and Nagar Brahmans of Gujarat—A study of the surnames and physical characters.

BIKASH CH. RAYCHOUDHURI, Calcutta.

In this paper an attempt has been made to estimate the limitation of proving racial identity based on similarities of surnames of the Nagar Brahmins of Gujarat and Kayasthas of Bengal. The paper has been divided into four sections. In section I the analysis of the earlier authors has been done with some suggestions; section II deals with the history of the Nagar Brahmans who figure prominently in the hypothesis advanced by Bhandrakar and Chanda; Section III deals with the comparative study of stature, head length, head breadth, nasal height, nasal breadth, cephalic index and nasal index of the Nagar Brahmans, Bengali Kayasthas, Vangaja Kayaysthas, Dakshin Rarhi Kayasthas, Baidyas and Dakshinatya Vadik Brahmans of Bengal amongst whom the similarities of some of the surnames are noticed. The value of 't' has also been calculated which proves in conclusive so far as Nagar Brahmins and Bengal Kayasthas are concerned regarding their racial identity. But with the Dakshinatya Vadik Brahmans and Vaidyas of Bengal does not seem to have any racial connection; section IV gives the summary of the discussion.

12. Dermatoglyphics of the Plantar Digitis—its relation to the finger prints.

DEBA PRASAD MUKHERJEE, Calcutta.

Toe and Sole prints were collected from both the sexes of thirteen tribes of Manipur, Nagaland and Assam during a dermatoglyphic survey. The toe prints of 116 male individuals have been discussed in this paper.

Whorls in toes range from 10% to 38% and Fibular Loops from 35% to 87%. Tibial Loops are up to 10% and Arches up to 55%. An inverse relationship is observed between the occurrence of patterns in Toes and Fingers. This is less marked among the Garo and Khasi.

The bipedal and bimanual distribution are in the reverse direction. Whorls are more common in left toes and Arches in right. High frequency of Whorls occurs on III toes, and also in II and IV. The Fibular Loops and Arches are most frequent on V and I toes, and Tibial Loops always on I. The digital distributions may have resulted from a more medial axis of the foot than that of the hand.

13. Tribal migration to Urban Industrial areas—its effects on health and nutrition of the tribals.

AMAL KUMAR DAS, Calcutta.

The role of the proximate principles of food in maintaining proper standard of health and nutrition has been discussed and the need for a balanced diet stressed.

People leading healthy lives for generations in a region can develop capacity for adjustments to local conditions for maintaining proper nutritional level.

In a diet study of an Oraon village near Lohardaga (Ranchi) in 1955, the daily Calori intake of a standard unit amounted to 2527, and the people were observed to be healthy and well-built.

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Overpopulaton in a limited area and need for cash money for paying off debts urged some tribals to migrate to urban industrial areas. But in spite of increase in cash earning there, their general health gradually deteriorated. Food was pretty costly and of doubtful purity in industrial area and air breathed was vitiated with dust and smoke. Many became addicted to heavy drinking and some contracted venereal diseases and some even tuberculosis.

Industrial employers should therefore take sufficient care to protect tribal recruits from these sources of deterioration of health, to minimise absentee-ism.

14. Widow Remarriage and Fertility.

MANINDRA KUMAR NAG, Calcutta.

The present analysis is based on the reproductive histories of 2689 ever-married women of seven villages in West Bengal. The frequency of remarriage of widows is higher among the Muslims than among the Hindus in general, but there are exceptions. Among the Hindu Muchi, 44% of the widows are found to have been remarried, and among the Muslim Sheikh only 5% of the widows are found to have been remarried. The loss of reproductive period per ever-married woman due to post-widowhood celibacy is 1·5 years for the Hindus and 1·0 year for the Muslims, but the fertility level of the Hindus is higher than that of the Muslims. The inter- and intra-group variations in fertility among the Hindus and Muslims cannot be explained by their variations either in the frequency of remarriage of widows or in the loss of reproductive period due to post-widowhood celibacy. Two reasons why the loss of reproductive period per ever-married woman due to post-widowhood celibacy is not as high as expected in the groups for which the frequency of remarriage is comparatively low are that (i) the average age at widowhood is comparatively high among them, and (ii) the proportion of women widowed is comparatively low among them. The latter two variables seem to be important in relation to fertility.

15. Demographic Effect of Firuz Tughlakh's raid into Orissa (1381 A.D.).

JATINDRA MOHAN DATTA, Calcutta.

Firuz Tughlak raided Orissa in 1361 A.D. Besides those killed in war, from about 5 to 6·5 lakhs were destroyed in cold blood. The estimated population about that date is about 30 lakhs. From about *one-sixth* to *one-fifth* of Orissa's population was killed. It is based on two contemporary official sources : (1) *the Sirat-i-Firuz-Shahi ;* and (2) Ainul-Mulk's *Insha-i-Mahru,* suppiemented by Afif's *Tarikh-i-Firuz-Shahi,* which have been followed by Dr. R. C. Majumdar in his DELHI SULTANATE.

16. Demographic Data from the Bible.

JATINDRA MOHAN DATTA, Calcutta.

Taking the data as given in the A.V. of the Bible to be correct, the rate of growth of the Israelites has been from Joseph's time to the Exodus, a period of 430 years 21·5% per decade, during the 40 years of sojourn in the Sinai peninsula 0·9% per decade; and from their entry into Canaan to David's time, a period of 270 years, 3·33% per decade (71).

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Plague and pestilence destroyed about 4% of population in 1320 B.C. and in David's time 4·5%—6·4%. During their sojourn in the Sinai peninsula, the population was of Regressive Type.

Much depends upon the correct Biblical chronology, about which scholars differ.

III. SOCIAL AND CULTURAL ANTHROPOLOGY

17. Comparative Study of the Kinship Systems of two Polyandrous Communities.

BHABANANDA MUKHERJEE, Calcutta.

1. Polyandry among the Jaunsari and the Toda has not developed the same patterns in their terminological and kinship systems. Cross-cousin marriage has basically aligned the relatives among the Toda into the traditional pattern of the South Indian kinship system. Equivalence of siblings and unity of sibling group are consistent with Jaunsari joint family structure in a fraternal polyandrous situation, whereas the situation is paradoxical among Toda who practise nonfraternal polyandry and cross-cousin marriage.

2. Fundamental differences between the two systems are noticed in the parents' and ego's generations which clearly bear out that they do not conform to any type. This is also supported by the differential applications of kinship criteria.

18. The Maler Social System : levels of Unity and extension.

L. P. VIDYARTHI, Ranchi.

The paper, methodological in nature, describes the net-work of relationship of a Maler as a member of the Paharia Community, as a member of the Maler tribe and then as a member of the "region of contacts" and above all as a member of his village and his lineage. It has been brought out that the unity of the Maler on the tribal level is to be noted only in their consciousness to be a Maler. The real unity among the Maler on an extra-village level is observed in terms of "region of contacts". A set of villages falling within a radius of ten miles are in mutual interaction with each other. Such regional contacts (extension of a village according to Opler) are observed in a Maler village owing to (i) Marriage, (ii) exchange of labour among relatives, (iii) visits on the occasion of festivals, (iv) showing of common weekly market, (v) and the regional *Sardari* system. The above analysis indicates that the interaction of a Maler village with the world outside is relatively less extensive than a Plain-dwelling Santhal or a Hindu village.

With these extensions, a Maler village is essentially a self-contained unit, which is marked with the following characteristics : (i) Sense of belongingness to a village, (ii) Idealisation for the village, (iii) relationships among the families of the village through the lineage and corporate groups, (iv) sharing of the same sacred places and sacred specialists by all the villagers, (v) the village panchayat, (vi) The village youth dormitory, (vi) and then a set of informal contacts and companionships.

19. Magico-religious ceremonies connected with the economic activities of the Lodhas.

P. K. BHOWMICK, Calcutta.

The Lodhas of Midnapur, are a denotified tribe of West Bengal. Declared criminals, they suffered a lot of harassment, till the revocation of the Criminal Tribes Act in 1951.

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Even so, they are a festive people, cheerful, both in body and mind. Besides their own festivals, they have assimilated a few others from the annual cycle of the neighbouring Hindus, along with the presiding gods and goddesses, and worship them. A few such festivals, connected with their economic activities and agricultural in nature, have been described in this paper. These are popularly known as—(1) Jathel, (2) Ashari, (3) Muchri, (4) Ceremony of the 'Nal' or reeds, (5) Worship of Bani, (6) Worship of Lakshmi and (7) Worship of Sar, and each is, more or less, connected with their agricultural and economic life.

But a sharp trend of assimilation of Hinduistic culture is discernable in these festivals, although, these have been tinged with tribal variations, here and there. It is an indication of the advancement of this tribe from the pool of backwardness. On the other hand they are also maintaining their own cultural distinctiveness.

20. Social Mobility Movement Among the Mahato of South Manbhum.

BIMAN KUMAR DAS GUPTA, Calcutta.

This paper deals with the trends of caste mobility movements among the Mahato of South Manbhum. Before the 1920's, they took part in group-dancing, practised widow-remarriage and took country liquor and fowl. During that period, they were not so conscious about their assumed relation with the Kurmis of the other parts of Bihar, U. P. & M. P. as also with the Kunbis of Maharashtra. Now-a-days, as a result of a series of caste meetings held in different areas of Manbhum, there has been a tendency of considering themselves as belonging to the same cultural stalk as that of the Kurmis of other parts of India. Concocted fictions tracing descent from Chhatrapati Shivaji, are there. Sacred thread is being worn. Group-dancing, wine, fowl and widow-remarriage have been forbidden. Use of veil has been introduced for married women. Recently, secular aspirations for economic and educational advancement have overshadowed their earlier exclusive concern with ritual purification.

21. Culture Zones of Rajasthan, Preliminary findings and a critique of methods.

P. K. MISRA, Nagpur.

The major portion of Rajasthan with two main Geographic regions namely one to the north-west of the Aravalli Hills and the other to the south-east, was during the British period under a number of Indian princes.

The north-western portion of Rajasthan forms the major part of the great Thar desert. The south-eastern portion comparatively has more of rains and is green.

Broadly, Rajasthani is the language of the whole of Rajasthan but it contains several dialects each of which demarcates a contiguous area. Rajasthani itself is bounded by Broj Bhasa and Bundeli in the east, with Bundeli, Marathi, Bhili, Khandesi and Gujarati in the south. On its west it has Sindhi and Lahnda and on its north Lahnda and Punjabi—all these surrouding dialects and languages including Rajasthani belong to the Indo-Aryan family.

The people of Rajasthan represent an interesting mosaic of caste groups, each having a distinct set of rules and behaviour.

The present paper is primarily concerned with a preliminary mapping out of the distributional zones of a few selected traits of material culture and delineating the nature of their possible interrelatedness. This paper also examines how far these trait areas are coterminous with Geographical regions and dialect areas and also how these are related to similar items of culture beyond the frontiers of Rajasthan.

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A study of this nature raises a number of fundamental problems of theoretical interest regarding classification of cultural forms, and also in the matter of diffusion of traits.

22. The Institution of Panji.

BAIDYANATH SARASWATI, Nagpur.

The system of keeping genealogical records among the Maithil Brahmans, concentrated in Mithila (North Bihar), was first introduced in 1326 A.D., and is still a living institution. The system is called Panji; the persons who record the genealogies are Panjikars.

The Maithil Panji not only records the genealogies of the families but also regulates the marriage system and determines the position of the individual in group hierarchy as affected by marriage alliances. The Panjikars hold their offices in village Saurath where every year, on auspicious days (Sudhas) thousands of people assemble to negotiate marriages. It is necessary for every person to get a certificate of non-relationship (Aswajana-patra) between the two contracting parties from these Panjikars.

The institution of Panji stimulated hierarchical notions in the regional social structure and encouraged hypergamous and polygynous marriages. Matrimony became a profession and Kulinism flourished. Under the impact of modern developments, the bridegroom's consideration has shifted from a kulin to a holder of University degrees, but the institution of Maithil Panji remains unaffected, for the solidarity of the Maithil society lies with this institution.

23. Industrialisation—Its effect on Economic and Socio-psychological life of tribals.

AMAL KUMAR DAS, Calcutta.

The scope of industrialisation and its recent rapid growth in India have been discussed.

The influences of this rapid industrialisation on the economic, social, psychological and moral aspects of the tribal peoples' lives have been examined.

Tribal migration to industrial areas and displacement of tribals due to installation of large industrial undertakings have been discussed and needful for their rehabilitation in areas similar to their traditional set up stressed.

The ill effects of living in industrial area have been discussed particularly, the upsetting of the family, interpersonal and social relationships, replacing their traditional community and family mindedness by self-centred attitude, and also disintegration of taboos and clan baviers, moral laxity, increased drinking habits and consequent physical deterioration and diseases.

Contacts with peoples of different ethnic groups have widened their sphere of knowledge, removed superstitious and broadened the mind and understanding. Political consciousness has started awakenning, but owing to their illiteracy, they are falling pray to trade unionisms and designing political groups who exploit them.

In spite of their eagerness to take to industry, they are yet psychologically inapt for machinery handling.

"Human Engineering", the new branch of Technology has therefore to be popularised here as in other advanced countries for co-ordination between industry and human reaction.

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24. Christianity in a Tribal Village.

K. MAHAPATRA, Bhubaneswar.

The paper is based on data from a Kandha village in Phulbani district of Orissa. It is a comparative study of the degree of cultural differentiation between the Christian and Non-Christian Sections of the tribe. The analysis of the data leads to the conclusion, that although the two sections of the population are distinguishable, both in terms of some selected cultural traits and as social groups—the pattern of interaction between them is co-operative.

25. Tribal life in Gujarat.

P. G. SHAH, Bombay.

The system adopted by the Gujarat Research Society for the study of the tribes of Gujarat covers besides cultural life, socio-economic conditions, a study of health and nutrition, physical measurements which includes important data such as anthropometric measurements, serological and intelligence testing so as to give a complete picture of tribal life in all its aspects social, material, physical and cultural.

Gujarat is a cultural, social, linguistic unit which has also acquired an independent political status since May 1960. The tribal life in this region has many unusual features. Like other people of Gujarat the tribes form a special group by themselves although spread over large areas. Out of 1,61,49,036 total population of Gujarat the tribal population forms 12·78 per cent of the total (20,64,522).

As the tribes are living in Gujarat for a long period the general culture of the people of Gujarat and the regional factors have influenced them very much and have produced a strong impact on their life. Yet the tribes have continued to maintain many tribal characteristics which set them apart as a group.

The main tribes of Gujarat are Bhils (8,47,879), Dublas (1,74,369), Naikas (1,28,604), Gamits (1,11,901), Dhankas (32,514), Kukanas (figures not available) Chodhras (figures not available) Dhodias (figures not available). The first four tribes form one group whereas the last four another. The first group is more backward than the second group as seen from their educational level, social customs, social level, superstitions, religion, economic level, aesthetic sense, food habits, observance of festivals etc.

Yet each tribe has something distinct by way of culture and so we find that physically, serologically, sub-group among one tribe differs from sub-group among other tribe *e.g.*, Tadvi-Bhils and Tadvi-Dhankas.

Thus the tribal life in Gujarat partakes many cultural peculiarities of the region with which are interwoven many general and special characteristics of tribal life which lend each tribe a peculiar character.

26. Cultural affiliation of Orissa on the basis of certain important material traits.

N. K. BEHURA, Calcutta.

Politically and linguistically Orissa consists of an area of 60,250 square miles consisting a population of 14,645,946 as per 1951 Census. It presents countless castes of the Hindu social order as well as a number of Dravidian and Mundari speaking tribes.

Analysing of a selected groups of material traits it has been observed that Orissa is an important meeting ground of the two major cultural traditions of India namely, Dravidian and Indo-Aryan.

Within the state itself, there are significant variations in material traits in the four broad regions namely Northern, Eastern, Western, and Southern. While

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some of these variations relate to ecological differences in these regions, the entire area is inhabited by people speaking a single dominant language namely, Oriya.

27. The Namputiris of Kerala.

K. V. KRISHNA AYYAR, Coimbatore.

The Brahmins of Kerala now consist of the Namputiris, Emprantiris, Ayyars and Pattars, and Konkanis. The Namputiris differ from the others in their mother tongue—which is Malayalam—restriction of the marriage to the eldest son, post-puberty marriage, polygamy, and impartibility of the family property.

The Konkanis came to Kerala to escape the religious persecution of the Portuguese; the Ayyars and Pattars after the conquest of Tinnevelly or Southern Pandya by the rulers of Travancore in the fourteenth century; the Emprantiris in consequence of the adoption, off and on, of the Kolattiri or Chirakkal princesses by the Travancore rulers. Nothing definite is known about the coming of the Namputiris.

As the other three divisions retain their separate mother-tongue even after their settlement in Kerala, and as Malayalam, the mother-tongue of the Namputiris is spoken only in Kerala, the ancestors of the Namputiris must have settled in Kerala before the common Dravida language spoken east and west of the Ghats branched off into Malayalam and Tamil. This process began with the Chola invasions inaugurated by Rajaraja I in 988, the invasions blocking the hitherto uninterrupted communication between the west coast and the east coast.

The arrival of the Brahmins in Kerala was not in the nature of a mass movement; it was a slow infiltration as in other parts of South India.

Namputiri with its contracted form *Nampuri* is a compound formed by the two words *Nampi* priest, learned man or saint, and *Sri* (written as *Tiri* in Dravida) august or auspicious. And just as *Svami Sri,* august chief or lord, became *Samutiri* and *Samuri* (Zamorin of Calicut) *Nampi Sri* became *Namputiri* and *Nampuri.* Chaplain Visscher of the early seventeenth century was the first western writer to refer to the Kerala Brahmins as *Namputiri* and *Nampuri,* though the thirteenth Chinese historian Chau Ju Kua calls Kerala by the name of the *Nanpi* country. The earliest inscription to recognise the Kerala Brahmins as a separate class belongs to 1229.

As early as the Samgham age the Brahmins had established their hold upon the people as priests and learned men.

By taking an active part in resisting the prolonged Chola aggression, they were also able to carve out little principalities of their own.

By entering into free unions with the women of the matrilineal but warlike Nayars, who were their comrades in arms, they established a personal hold on them by the bonds of affection and filial respect.

The free unions made the Namputiris averse to sacramental marriage within the caste. And the eldest son alone came to marry within the caste. As marriage below the caste was unthinkable, the marriage of the Namputiri girls had to be postponed, virgin marriage gave place to post puberty marriage. As only the eldest son married, polygamy also came into vogue. And as the younger sons remained in theory bachelors, the family property could not be divided.

28. Pronouns of Address in a Few Indian Languages.

MANINDRA KUMAR NAG, Calcutta.

The paper deals with the association of the pronouns of address with two dimensions of social life, namely, power and solidarity, in Bengali, Hindi, Urdu and Gujerati. It indicates the semantic and stylistic variations of the pronouns of

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address in these languages and seeks to find out the correlation, if any, between semantic change and social change.

Compared to the contemporary European languages, all the four Indian languages are found to have more non-reciprocal power-semantics. A study of the differential changes in pronominal address during the last two or three generations reveals that the solidarity semantic has been gaining supremacy over power semantic in all the four Indian languages, as in European languages, but there have been more changes in Bengali than in the other three. The changes in Bengali show the same trend as in European languages, that is, towards the dominance of the mutual use of the pronominal form of condescension and intimacy among the members of a family and among friends. The apparent trend of change in the other three Indian languages towards the mutual use of the pronominal form of reverence and formality is in contrast with the European trend. Attempt has been made to explain the difference.

29. A short general background of Assam and Khasi and Jaintia Hills.

PRANAB KUMAR DAS GUPTA, Shillong.

Assam was the country known as *Pragjyotisha,* in the days of the epics and as *Kamrupa,* in medieval times and has been mentioned both in the *Ramayana* and *Mahabharata.*

This paper deals in brief with the mythological, racial, and historical background of Assam and Khasi & Jaintia Hills.

30. The Influence of Sources of Information in the Propagation of Certain Family Planning Methods.

PRAFULLA C. BEBARTA, Bombay.

In this paper an attempt is made to explore the influence of information sources in the propagation of certain family planning methods. The sample comprises of 666 women of Greater Bombay who were married at the time of the Survey. Out of them 48·3 per cent were ignorant of any family planning methods, 51·7 per cent were aware of one or other methods, and 17·3 per cent had ever used any methods.

The findings reveal that the most influential sources in imparting knowledge on methods were friends, neighbours and acquaintances. The physicians were most influential in the use of methods. And the husbands were the most effective source in converting knowledge into use.

Female sterilization was comparatively more propogated through medical sources, and other methods through informal interpersonal sources. The women who adopted sterilization or diaphragm, pessary and jelly, a larger percentage of them knew from medical sources. About other methods they knew from interpersonal sources. Medical sources were influential in converting the knowledge on many methods into use.

Many more studies are needed on this line and other related lines in testing hypotheses, in building up theories and also in making models for action research.

31. Hand-made Pottery in Madhya Pradesh and the Distribution of the Hand-made Pottery in India.

SUHAS KUMAR BISWAS, Calcutta.

The first part of the paper has been devoted to describe in detail the process of manufacturing the handmade pottery in three villages of the Madhya Pradesh.

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The hand-made potter caste, known as the KUMHAR, is sub-divided into a number of endogamous groups. The hand-made potters are regarded by the upper castes as lower in status than those who turn out pottery on the wheel.

In the second part, the hand-made pottery manufacturing techniques of different regions of India, including the Andaman and the Nicobar Islands have been compared. This is based on the tempering materials added to the primary clay for making different types of pots, the shaping and the firing processes.

The existence of hand-made pottery in the north-east India is more widespread than its occurrence in the rest of India. It is likely that the north-east and the South Indian hand-made pottery industry is South East Asian in origin.

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SECTION OF MEDICAL AND VETERINARY SCIENCES

President :—Dr. J. C. Banerjea, M.B. (Cal.), M.R.C.P. (Lond.), M.R.C.S. (Eng.)

Abstracts

MEDICAL SCIENCES

1. Histochemical Changes in the Endometrium of Rabbit Induced by Oral Administration of Indigenous Contraceptive Drugs.

H. S. CHAKRAVARTI, Calcutta.

While searching for a contraceptive drug effective by oral route, the author came across a formula in Ayurvedic Medicine (Bhava-Prakasha), consisting of *Embelia ribes* (N. O. Myrinicae), Piper *longum* (N. O. Piparacae), borax and asafaetida. This preparation is to be taken by the female partner immediately after menstruation for a few days and has been emphatically reported to be effective in preventing conception.

In order to find out its mode of action, if any, experiments were carried out in immature female rabbits in two groups. In one group (control) only oestrogen was injected 50 I.V., I.M. alternate days for 3 days and in another group (experimental) in addition to oestrogen injections, above oral contraceptive drug was given daily. Animals were sacrificed on the 6th day and, cornu of the uterus was examined for any histochemical change.

Result showed that the intense alkaline phosphatase reaction in endometrium produced by administration of oestrogen, was very much inhibited by simultaneous administration of this drug by mouth. Also in the experimental group there were marked reduction of the polysaccharide structure (glycogen) and nucleic acid substance (DNA & RNA) in the cell of the endomectrium as compared with the control group. It seems probable that such inhibition of the cellular activity of the endometrium by administration of the drug may be effective in preventing conception. Further work in this line is in progress.

2. Neurogenic influence on absorption of sugar in the Rat Inestine.

R. N. SEN, Sambalpur.

Rate of intestinal absorption of three sugar compounds (d-glucose, d-mannose and d-fructose) was studied against concentration gradient with and without vagal stimulation in vitro methods. Special feature of this vitro preparation was eversion of the intestine, so that mucosal surfaces of tied sacs were directly exposed to oxygenated medium. The technique of Wilson & Wiseman was followed.

The results so far obtained suggest that vagal stimulation enhances the rate of absorption of d-glucose across the wall of small intestine of rats. Vagal stimulation also increases the rate of absorption of d-mannose and d-fructose to a minor extent. These two compounds however are not actively transported across the wall of rat intestine.

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3. A comparative Study of the Diuretic effect of the Extractives from Fresh and Dried Plants "Kuliakhara" (*Asteracantha longifolia* Nees).

P. K. SANYAL and P. N. VARMA, Calcutta.

From the previous work of Sanyal and Bhattacharya it has been observed that the plant "Kuliakhara" as a whole has a good diuretic effect on rats. The drug is always used fresh, when available, by the Ayurvedic Physicians. It was, therefore, thought that the extractives obtained from fresh plants be compared with extractives of dried plants collected 6 months before the experiment.

Maximum diuretic effect was observed with 50 per cent alcoholic extract of the dry plant which contained no alkaloidal bodies according to investigations done previously. It was of the order of 3·4 times urine volume increase while its corresponding extract from fresh plant which gave positive tests for alkaloids gave 1·9 times urine volume increase. It seems that alkaloidal bodies of the plant have little to do with its diuretic effect.

As far as water extracts are concerned the decoction of fresh plant gave slightly better result as compared to the decoction of the dried plant.. Water extracts of fresh plant are even better in diuretic effect than the 50 per cent alcoholic extract of fresh plants, giving positive test of alkaloidal bodies. This further goes to support the view that alkaloidal bodies have either no or very little role in the diuretic activity of the plant. The better activity of the fresh plants may be due to more of extractables sugars, polysaccharides and the inorganic salts.

There seems to be a close relation between the inorganic content of the extractive and diuretic property but they are not well marked and not applicable to all cases. In spite of this, from the correlating figures so far obtained, the inorganic content of the extractive has an important role.

95 per cent alcoholic extract of fresh plants gave no better results than those obtained from 50 per cent alcoholic extract. Average increase in urine output compared to control was 1·8 times.

4. *Asteracantha longifolia* Nees—its diuretic effects on rats.

P. K. SANYAL and S. K. BHATTACHARYA, Calcutta.

The drug Kuliakhara *Asteracantha longifolia,* Nees, known in Hindi Materia Medica as colling, diuretic and stimulating, has been tested for its diuretic effects on groups of male rats. The plant as a whole and its different parts like flower leaves, stem and root were extracted by water, 50% alcohol and 100% alcohol (100%—w/v,). It has been shown that :

1. The drug possesses very reliable diuretic action in doses 4 c.c./100 gm. which goes up to about 300% above saline or water control.
2. Roots have negligible while flowers have moderate action.
3. Leaves, stem and the whole plant possess high diuretic action.
4. Alcoholic extract 50% possesses more diuretic action than watery extract even if it is measured against alcoholc control.
5. Alcoholic extract 100% does not show any advantage over 50% alcoholic extract.
6. The drug is singularly free from toxic action, even if it is administered for months at a stretch, and in this respect it is preferable to mercurials and the recent synthetic drugs like Diamox or Chlorothiazide.
7. Much higher doses have been administered orally and it has not been possible even with very high dose to produce any toxic effect whatsoever by any of the doses which could be administered by a syringe and stomach tube. On the other hand the animal seems to gain in weight and agility.

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5. Preliminary Study on the Haematinic Properties of *"Kuliakhara"* (*Asteracantha longifolia*, Nees).

P. K. SANYAL and P. N. VARMA, Calcutta.

While treating number of patients for Œdema, Ascites and Anasarca, it was observed that with extract of *Kuliakhara*—the Haemoglobin content of all the patients improved considerably. The Iron content of the Extract of *Kuliakhara* was determined by Mercuric Nitrate—Ammonium thiocyanate method. The percentage of Iron content in the ash was found to be 22·54 per cent.

A number of male and female patients in three batches were given extract of Asteracantha (Water Extract) under hospitalised conditions. The first two batches consisting of three males and three females were given Asteracantha preparations by mouth and another (second) two batches consisting of three males and three females were given the same. Asteracantha preparation along with some reputable Iron preparation of the trade. A third batch was treated mainly with diets without any Iron or Asteracantha preparations. The treatment was carried out for five weeks for all the above cases. It was observed that the first two batches had remarkable changes in Haemoglobin, the second two batches had practically identical changes to first two batches while the third batch (standard) showed practically no improvement.

It was established, therefore, that Asteracantha preparations had a remarkable Haematinic effect which may be due to the Iron content of the drug.

6. Studies on the Germination of Bacterial Spores-Effect of Incubation of *Bacillus Megatherium* Spores in Peptone and Glucose solutions.

V. SUBBA RAO and D. VISWESWARAM, Waltair.

The effect of prolonged incubation of *B. megatherium* spores at 37°C in peptone and glucose solutions was studied. Nearly 95% of the initial number of spores were found to lose their heat resistance within 3 hours when incubated in 1) 1% peptone solution and 2) 1% peptone and 1% glucose mixture. After 3 hours the solutions turned turbid indicating that the organisms were growing and multiplying. Heat resistance tests performed after 24 hours of incubation indicated that the vegetative cells were again forming into spores. The spore counts were determined daily till 7 days and the results were plotted against time of incubation. The spore counts were found to increase in both the solutions but in the case of peptone solution, the increase was more rapid than in the case of peptone-glucose mixture.

From this work, it is found that peptone solution favours germination as well as sporulation of *B. megatherium*. Glucose appears to have a definite inhibitory effect on the sporulation of the organism, though it does not appear to have any effect on the germination of these spores. It is proposed to study further the different conditions that favour these changes.

7. The effect of gastric secretory stimulant on Sodium and Potassium contents of Gastric Juice and their relationship with its acidity and pH in human subjects.

M. L. PAI, Baroda.

Twenty-four healthy adult male medical students were chosen as subjects after their fractional gastric analysis examination with alcohol as test meal was found to be normal. Ninety gastric samples were analysed for free and total acidity, pH, sodium and potassium contents, the latter two by the method of flame photo-

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metric analysis, using "EEL" flame photometer. The free acidity ranged from 11·5 to 122·0 mEq/L with a mean of 34·6±2·18. The pH varied from 1·32 to 6·45 with a mean of 2·16±0·12. The potassium content ranged from 4·9 to 42·3 mEq/L with a mean of 17·1±0·52. The sodium content varied from 16·9 to 84·3 mEq/L with a mean of 44·6±2·98. A reciprocal relationship was found to be present between the acidity of the gastric juice on one hand and its sodium and potassium contents on the other. This relationship was found to be statistically significant. The correlation between acidity and sodium was 0·43, that between pH and potassium was 0·21 and the one between acidity and pH was 0·38, all the above three values being found to be statistically significant. The significance of the above findings has been discussed in the paper.

8. Modifications in the synthesis of Progesterone from Diosgenin.

V. M. BAKSHI and Y. K. HAMIED, Bombay.

Modifications were used and conditions standardised for the synthesis of Progesterone from Diosgenin. Extraction of 4% Sulphuric acid hydrolysed Dioscorea Deltoid roots with carbon tetrachloride yielded spectroscopically pure Diosgenin. This was converted to pseudodiosgenin acetate which was then oxidised with Chromic acid to Δ^{16} pregnenolone acetate. Low pressure hydrogenation in ethanol using Raney nickel as catalyst selectively reduced the Δ^{16} double bond of Δ^{16} pregnenolone acetate and then deacetylation with 2% methanolic sodium hydroxide gave pregnenolone. Oppenauer oxidation of pregnenolone with acetone and aluminium tert.-butoxide as catalyst yielded progesterone in an over all 40% yield from Diosgenin. The purity of intermediate compounds was checked by their melting points and infrared spectra.

9. Preliminary Results of a Survey of the Charasteristics of a Normal Indian Adult.

K. VENKATARAMAN and S. SOMASUNDARAM, Trombay.

Standards for protection from ionizing radiation are recommended by the International Commission on Radiological Protection ICRP. Maximum permissible concentrations of radio isotopes in air and water (food) and the maximum permissible body burden of radio-isotopes are recommended by the sub-committee II on permissible dose for internal exposure. These values are based on the characteristics of a standard man, which are typical of an average Western adult. Preliminary studies carried out by the Health Physics Division, Atomic Energy Establishment, Trombay indicated that the characteristics of a normal Indian adult may differ significantly from those of the ICRP standard man so as to warrant modification of the radiation protection standards in the light of Indian conditions. In order to examine this problem more thoroughly, the Division has started work on the establishment of the characteristics of the normal Indian adult. Data on total body weight and weights of individual body organs have been collected from the post mortem records of a few hospitals in Maharashtra, Tamil Nad and Utter Pradesh states. These data have been statistically analysed and evaluated for any significant differences between these regions.

10. Pharmacology of Petroleum Ether.

BIDHU B. ROY, Calcutta.

Petroleum ether given intratracheally to anaesthetised cats produced abrupt fall of blood pressure, slowing of heart rate and arrest of respiration, the hypo-

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tension appearing earlier, and sustaining longer, than either the bradycardia or the apnoea. Bilateral cervical vagotomy could prevent the last two effects but atropine could prevent only the bradycardia. Neither procedure had any significant effect on the hypotension, which also remained unaffected by prior administration of antihistaminics. Acetylcholine, in presence of atropine, produced the usual vasopressor response during the period of maximum hypotension induced by petroleum ether; the degree and duration of the hypotension was, however, considerably curtailed by prior administration of hexamethonium.

The mechanism involved is discussed and attention is drawn to the close similarity between the triple response produced by petroleum ether and some of the veratrum ester alkaloids.

11. Role of Plasma Cholesterol in Angina of Effort.

D. P. BASU and K. B. BAKSHI, Calcutta.

(a) 20 patients were studied in this group. The total cholesterol mean was 234·7 mg.%; Free cholesterol mean was 61·4; $F/T \times 100$ was 26.

(b) These patients showed a much greater tendency to hypercholesterolaemia; of the 20 patients 19 showed plasma cholesterol greater than normal mean.

(c) Free cholesterol concentration in the plasma showed a similar general and indeed proportional increase above the normal mean, the value of $F/T \times 100$ remaining unchanged.

(d) The age effect found in acute myocardial infarction did not exist in this group of patients.

(e) The tendency to hypercholesterolaemia is roughly related to the time elapsed since the first attack of pain.

12. Localization of Cholera Bacteriophages after Intravenous Injections.

S. MUKERJEE, Calcutta.

A group IV cholera bacteriophage filtrate was administered intravenously in a series of rabbits. They were sacrificed at planned intervals from 15 minutes to 72 hours and localization of phage in different organs were tested by plating homogenisates of the organs with a sensitive strain of *V. cholerae* and counting the plaques formed after 24 hours. Viable phage particles could be isolated within 15 minutes of the injection from all the organs tested namely, heart's blood, spleen, liver, kidney, bladder, intestinal walls, bile and contents of the small intestine. Phage concentrations gradually fell with time but viable phage could still be isolated from all organs after 48 hours.

We have reported observations that the gut-inflammatory reaction caused by *V. cholerae* in the tied loop of intestine of a rabbit could be prevented by injecting bacteriophages. Intravenously administered phages are likely to reach the site of infection early and in sufficient concentration to exert their effects on the disease process.

Recently a Russian team of scientists working in East Pakistan reported satisfactory results in treating cholera cases by bacteriophages. The present findings lend support to the rationale of their application of intravenous phage therapy as supplement to the usual oral administration of bacteriophages.

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13. Study of the Dynamics of Central and Peripheral Pressure Pulses in cases of Coarctation of the Aorta (preoperative and two postoperative cases).

H. K. BOSE, Calcutta.

(1) Sixteen cases of coarctation of the aorta were studied, where central and peripheral pulse tracings were obtained by indirect method. In 11 cases, coarctation also involved atypical sites.

(2) 5 cases were male and 8 were female. Among the male cases three had in the atypical site, of which two had in the abdominal aorta and the others had the coarctation in the left carotid and in the left subclavian as well. Among the female cases, four had in the abdominal aorta, three in the left carotid as well as in the left subclavian arteries. In the remaining one, the right innominate artery was only involved but without affecting the aorta.

(3) Similar studies were carried out on sixteen normal subjects of the same age group.

(4) Normally the Femoral pulse precedes the Brachial by an average of about 0·02 sec.

(5) The transmission and the build-up time of the pressure pulses distal to coarctation are increased than the brachial of the same patient. The upstroke is small, delayed with broad, low, rounded peak, often plateau-like or has a characteristic saw-tooth contour appearing as an almost smooth, flat curve indicating no landmark of the beginning of diastole.

(6) After operation (in two cases) definite improvements in the pulse wave characteristics were noted.

(7) The haemodynamic factors involved in the genesis of such pulse wave propagation have been discussed.

14. Preliminary studies on Stephania hernandifolia as an Ecbolic drug and its role in contraception in mice.

N. K. ROY and A. N. BOSE, Calcutta.

Stephania hernandifolia (Beng. Aknadi, Sans. Patha) is widely used in Ayurvedic and other system of medicine (Roxburgh) particularly in Sylhet. If applied on os uterus it expedites Labour (Biswas). From a sister species *S. glabra* one alkaloid has been isolated having antimicrobial activity (Roy Choudhury and Siddiqui). In Japan a good number of alkaloids have been isolated from *S. japanica* (Chopra) one cepharanthene having antitubercular activity. Work with *Stephania hernandifolia* (Aknadi of Bengal) carried out in our laboratory reveals that alkaloids isolated from the roots, rhizomes and leaves though having spasmolytic effect on the intestinal movement of rat and guineapig, do not affect the uterine tissue of these animals in rest or active state. The maximum action noticed is some increase in tone and tendency to regularize irregular spasmodic movement. Fresh leaf extract however while exerting inhibitory effect on the intestinal movement shows definite spasmodic effect on the uterine tissue in activity in rats and guinea pigs. It has however been observed that fresh leaf extract orally administered in mice during mating time appreciably prevents conception. The animals in a very high percentage of cases fail to conceive till the drug is discontinued. The effect of the drug however continues for, one, some time two estrous cycles. Further work for determining the proper time during the estrous cycle for administration of the drug and systemic changes responsible for the action is being continued.

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15. Clinical evaluation of a new oral synthetic hypoglycaemic agent.

A. N. BOSE, Calcutta.

Detailed pharmacological work on a number of synthetic biguanide compounds carried out in this laboratory, showed that the compound termed AD_3, (N'-α-phenylethyl-biguanide hydrochloride) exerts a powerful and sustained hypoglycaemic activity in animals, while possessing a low toxicity and satisfactory tolerance even or prolonged administration. In consideration of these findings, the drug was put to clinical trial on cases of diabetes in the different wards. Ten cases, all indoor patient and adults of diabetes were studied. After a thorough physical and biochemical examinations, the patients were put under a stock diet of 2000 calories, for an observation period of one week. If the blood sugar was not controlled, the patient was put on AD_3 the dose being gradually increased from 50 mg. to 100 mg. three times a day, given before meals. Urine was checked daily for sugar and acetone bodies. Blood sugar was estimated every week. The total period of drug intake varied from case to case, the minimum being 10 days and maximum 3 months.

The clinical trials show that AD_3 exerts a satisfactory control of the diabetic state, the blood sugar is gradually controlled with slight increase in weight and a healthy appearance. In no case acetonuria was detected during therapy, and there was no complaint of nausea, vomiting or headache or diarrhoea even on prolonged administration. It is concluded that the drug AD_3 (a new biguanide) possesses satisfactory therapeutic possibility and can be safely used on large number of cases for the control of adult diabetes.

16. Haemagglutination and the complement fixation test in Leprosy. A comparative study.

A. N. ROY, Calcutta.

In an earlier report it has been observed that the CF reaction of leprosy sera tested with antigen made of bacillary emulsion of Myco-bacteria leprae gives specific and sensitive reaction and that this antigen does not show any cross reaction with sera of tuberculosis cases. Haemagglutination reaction of sera of leprosy cases tested by Middlebrook-Dubo's test method has been reported to give high percentage of positive result. But the haemagglutination test is considered as non-specific.

In the context of these two reports a study was undertaken to compare the CF and Haemagglutination tests reaction of sera of clinically diagnosed leprosy cases. Present paper shows the result of this comparative study of sera of lepromatous and tuberenloid type of leprosy cases examined by two antigens—one specific and the other non-specific.

17. Some clinical observations and necessary conclusions in the Chemotherapy of Pulmonary Tuberculosis.

SHIBDAS BHATTACHARYA and NARAYAN CH. BHATTACHARYA, Rajpur.

Of all previously trumpeted Antitubercular drugs streptomycin, Isoniazide and Paraamino-salicylic-acid only are used presently. Proper evaluation of their merits and demerits is necessary.

Tuberculosis has tendency for self-limitation. Hence to avoid false conclusions effective drug must clinically improve 70 to 90% of all cases within one month.

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With streptomycin—90% of all cases clinically improve in 15 to 30 days. Usually severe cases require surgical interferences, in addition, for cure. Prolonged use for 1½ years to 2 years with increasing intervals between two injections is necessary for preventing relapses. Usual total dose is 120 to 200 gm. Relapse cases also improve as in original case.. No drug resistance is noted. Some cases improve partially only. Improvement with Prednisolone is noted here. Rarely streptomycin may flare up disease. Four case records are cited. Mild streptomycin-sensitiveness develops after prolonged administration in some cases. Few are streptomycin sensitive from beginning. Streptomycin acts better and quicker than I.N.H. or P.A.S. Case records are cited. Combined P.P. or A.P. and streptomycin treatment gives better and quicker result than either alone.

With Isoniazide no marked clinical improvement in short period occurs, so also with P.A.S. Present antitubercular drug of choice is streptomycin.

18. The Antiveratrinic action of fifteen local Anaesthetics.

V. N. SHARMA, Jaipur.

The antiveratrinic activity of fifteen local anaesthetics are reported against veratrine response induced in frog's sartorious muscle by veratridine 1 :10 million. 1-RBO-12-A C-10, U-0045, U-1804, U-2397, U-0069, P-267 and U-0172 possess strong antiveratrinic property. Next in order of potency are U-0575, U-0177, U-2363, U-0290 and P-169. McN-A-67-11 and 'Lignocaine are less effective than quinidine. The role of potassium responsible for veratrinic action of veratridine and suppression of efflux of this ion by local anaesthetics has also been studied.

19. Study of three Alpha-aminoethyl Esters of substituted Benzoic Acid on Cardiac, Skeletal and Smooth Muscles.

F. S. K. BARAR and V. N. SHARMA, Jaipur.

Three alpha-aminoethyl esters of substituted benzoic acid closely resembling procaine hydrochloride structurally have been studied for their actions on the cardiac, skeletal and smooth muscles.

All the three agents exhibited a negative inotropic and chronotropic effect on the amphibian and mammalian hearts. They also caused a reduction in the coronary flow, as determined in the perfused rabbit heart. McN-A-0286-11 showed maximum depressant activity on amphibian myocardium while McN-A-285-11 had maximum depressant activity on mammalian myocardium. This differential action could be explained by a species difference.

The antiacetylcholine activity has been worked out on the skeletal and smooth muscles. McN-A-240-11 exhibited maximum skeletal muscle relaxing activity, McN-A-285-11 had maximum spasmolytic activity on the guinea-pig ileum and McN-A-286-11 had maximum activity as a bronchodilator and on the isolated rat uterus.

The results have been discussed in the light of available literature.

20. Suppression of Acute Ventricular Tachycardia in dogs by Three Benzoic Acid Derivatives.

V. N. SHARMA and K. P. SINGH, Jaipur.

Three benzoic acid derivatives viz., B-Diethylaminoethyl 2 :3 :5 :6 tetramethyl benzoate (McN-29-11), Tridiurecaine (McN-100) and 2-Methyltrimethylene diure-

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caine dioxalate (McN-120-41) have been studied for their suppression effect on ectopic ventricular tachycardia following two stage coronary ligation in dogs.

B-Diethylaminoethyl 2 :3 :5 :6 tetramethyl benzoate (McN-A-29-11) was found to be significantly potent in restoring normal sinus rhythm in all the tests.

All the compounds had bradycardiac effect on the total heart rate which was, however, short lived.

21. Antiacetylcholine, Antiaccelerator and local Anaesthetic activity of some Quinidine like drugs.

V. N. SHARMA, Jaipur.

Fifteen new compounds, seven of which are derivatives of benzoic acid were studied for their antiacetylcholine, decelerator and local anaesthetic activities. The antagonistic action to acetylcholine was studied on frog rectus abdominis muscle. The antiaccelerator activity was determined in the heart lung preparation in dogs. The local anaesthetic activity was investigated on guinea--pig cornea for surcace anaesthetic effect, the intradermal injection method was employed for infiltration anaesthesia and frog's lumbar plexus for conduction anaesthesia. Local tissue irritancy was found by the rabbit eye test, trypan blue test in rabbits and rabbit ear test.

The correlation between local anaesthetic and antiarrhythmic actions is rather a close one (rank correlation coefficient $r=0.73$). A similar but less marked parallelism existed between antiacetylcholine and antiarrhythmic properties ($r=0.69$). Next is the correlation between antiacetylcholine and local anaesthetic action ($r=0.53$). The parallelism between antiaccelerator and antiarrhythmic ($r=0.41$); antiaccelerator and local anaesthetic ($r=0.35$) and between antiacetylcholine and antiaccelerator activities ($r=0.13$) was, however, not significant.

Three compounds viz U-0290, 1-RBO-12-A and U-2397 exhibited strong potency and low toxicity and hence warrant clinical trials in tachycardia as well as for their local anaesthetic activityy.

22. Vitamin A metabolism in Cirrhosis Liver.

M. L. GUPTA and R. L. AJMERA, Jaipur.

Metabolism of Vitamin A in 14 patients of cirrhosis of liver was studied. Vitamin A and carotenoids were estimated colorimetrically at 610 mu. (Carr-Price method) and 445 mu. respectively in blood before and 5 and 24 hrs. after administration of a test dose of 3 lac. I.U. of Vitamin A (Glaxo) orally. Similarly Vitamin A and carotenoids were estimated in urine of 24 hrs. before and after the test dose.

The resting plasma levels of Vitamin A and carotenoids were 26.3 ± 2.1 (16·8–47) and 41.5 ± 3.3 (22·5–60) ug. % respectively. The low plasma level of Vitamin A may probably be due to exhaustion of hepatic reserves of Vitamin A and excretion in urine. The low carotene level may be due to anorexia, and defective absorption due to bile salt deficiency. The 24 hours urinary excretion of Vitamin A was 24.9 ± 7.7 ug. which may be due to associated renal glomerular damage. Carotenoids were not excreted by any patient.

After the test dose the plasma level of Vitamin A rose to 98.1 ± 5.2 ug. in 5 hours and came down to 45.1 ± 3.5 ug. in 24 hours, while plasma carotenoid level did not show any significant change. This flattened tolerance to Vitamin A, low rise after 5 hours and high level after 24 hours as compared to the resting level is possibly due to defective absorption from the intestines, excretion in the urine and reduced storing capacity of liver.

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The 24 hours urinary excretion of Vitamin A (33·0±7·9 ug.) after the test dose was not significantly higher than the resting excretion. Carotenoids were not excreted in urine.

23. Vitamin A metabolism in Nephrotic Syndrome.

M. L. GUPTA and R. L. AJMERA, Jaipur.

Metabolism of Vitamin A was studied in 8 patients of nephrotic syndrome, Vitamin A and carotenoids were estimated colorimetrically at 610 mu. (Carr-Price Method) and 445 mu. respectively in blood before and 5 and 24 hours after administration of an oral test dose of 3 lac. I.U. of Vitamin A (Glaxo). Similarly Vitamin A and carotenoids were also estimated in urine of 24 hours before and after the test dose.

The resting plasma levels of Vitamin A and carotenoids were 79±8·8 (41·4–118·8) and 92·3±11·5 (41·2–141·5) ug. % respectively. The significantly higher concentration of Vitamin A in plasma may possibly be due to reduced storing capacity of liver and or kidney. The carotenoids concentration was within normal limits. The 24 hours urinary excretion of Vitamin A was 66·5±17·2 ug. which may be due to the glomerular affection. Carotenoids were not excreted by any patient.

After the test dose the plasma levels of Vitamin A rose to 202·2±18 ug. % in 5 hours and came down to 116±12·6 ug. % in 24 hours while plasma carotenoid level did not show any significant change from the resting levels. The high levels of Vitamin A after 5 and 24 hours may be due to (i) high resting levels and (ii) disturbed storage mechanism of kidney and possibly of liver also. The 24 hours urinary excretion of Vitamin A after the test dose was 119·5±29·2 ug. which was not significantly different from the resting excretion statistically. Carotenoids were not excreted in urine.

24. Vitamin A metabolism in Ch. Suppurative conditions of Lung.

M. L. GUPTA and R. L. AJMERA, Jaipur.

Metabolism of Vitamin A was studied in 7 patients of Ch. suppurative conditions of lung. Vitamin A and carotenoids were estimated colorimetrically at 610 mu. (Carr-Price method) and 445 mu. respectively in blood before and 5 and 24 hours after administration of an oral test dose of 3 lac. I.U. of Vitamin A (Glaxo). Similarly Vitamin A and carotenoids were also estimated in urine of 24 hours before and after the test dose.

The resting plasma levels of Vitamin A and carotenoids were 48·1±2·4 (40·9–52·1) and 85·1±9·2 (48–112·5) ug. % respectively. Both the levels were within normal limits, though the carotenoid levels in these cases were higher than in the normal subjects. Only one patient excreted 28·2 ug. Vitamin A in 24 hours urine. Carotenoids were not excreted by an patients.

The low resting plasma level of Vitamin A has been reported by many workers in acute inflammatory conditions of lung, which is possibly due to an associated renal glomerular damage causing excretion of Vitamin A in urine. The normal Vitamin A level in Ch. Suppurative pulmonary conditions is possibly due to absence of any renal damage or if it is initially present, it has recovered either completely or partially as only one patient out of the 7 excreted Vitamin A in urine.

After the test dose the plasma levels of Vitamin A rose to 143·6±9·2 ug. % in 5 hours and came down to 55·6±2·4 ug. in 24 hours. These levels were not significantly different from the normal subjects indicating the normal removal and storage capacity of liver and other tissues and normal intestinal absorption. The carotenoid levels did not show any significant change from the resting levels. After the test

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dose 3 out of 7 subjects excreted Vitamin A 4·2—50 ug.) in 4 hours urine indicating a partial recoverly of renal glomerular damage in these subjects.

VETERINARY SCIENCES

25. The diagnosis of Cysticercosis in goats and sheep by Haemagglutination test.

G. BISWAL, S. N. PANDA and D. B. MISRA, Cuttack.

The incidence of cysticercosis in domestic ruminants is high in this country and elsewhere, but there is no reliable method of diagnosis during life.

Sera from 81 goats and 67 sheep were tested with Boyden's tannic acid Haemagglutination Test in order to ascertain the usefulness of this test in the diagnosis of *Cysticercus tenuicollis* infection in these animals. Unconcentrated cyst fluid was used as the antigen. In 90 goats and sheep with cysticercosis, 77 (85·5%) showed haemagglutination titres of 1 : 80 and more while 53 (91·4%) out of 58 negative animals reacted only at 1 : 10 dilution of their sera. Boarderline serum titres of 1 :20 and 1 : 40 were observed in 14·4% positive and 8·6% negative animals. For diagnostic purpose, a title of 1 : 80 and above might be regarded as positive. The precipitation test was found to be of little value for the diagnosis of cysticercosis. The importance of using sensetive serological tests in the diagnosis of cysticercosis in animals has been discussed and the extent of limitation, under certain circumstances, has been pointed out.

To the knowledge of the authors this is perhaps the first report recorded in the literature for the diagnosis of cysticercosis in goats and sheep by Haemagglutination Test.

26. An investigation into the incidence of Brucellosis in fowls.

J. DAS, S. N. PANDA. N. K. DUTTA and B. N. ACHARYA, Bhubaneswar.

Brucellosis is known to occur in cattle, sheep and goats of India, but there is no information about its incidence in fowls. The possibility of *Brucella* infection in poultry was investigated in 150 birds by testing their sera for the presence of the agglutinins against *Br. abortus*. On the basis of agglutination and agglutinin absorption tests, it was found that 12 (8%) birds had serum titres enabling them to be classified as "positive reactors". Specificity of the serological reaction was studied by heat treatment of the serum samples of positive reactors. Some of the *Brucella* positive unheated serum samples cross-agglutinated with *Sal. puliorum* antigen. Further work is in progress. The significance of these observations in relation to the epidemiology of Brucellosis in fowls has been duscussed.

27. Histopathology of Bovine Arteriosclerosis due to Onchocerca armillata.

G. BISWAL, B. C. NAYAK and S. C. MOHAPATRA, Cuttack.

Records on sclerotic lesions due to the parasite *Onchocerca armillate* are very few and during the course of routine post-mortem examinations the authors recorded six cases of this condition in two bulls, three bullocks and one heifer. Aortic lesions associated with dilatation and hypertrophy of left ventricle, vulvular lesions, hydropericardium, hydroperitoneum, focal fibrinous pericarditis, catarrhal and catarrho-haemorrhagic enteritis were encountered at necropsy.

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Macroscopically diffuse conspicuous lesions in the thoracic aorta characterised by plaques with depressed centres, raised up yellowish to greyish streaks, and innumerable minute nodules resulting in large nodular elevations due to their fusion, were present. The lesions in the abdominal aorta were discrete. The vasavasorum were involved in all the specimens and adult parasites were visible under the intima.

Sections of the lesions stained with Haematoxylin and Eosin, Verhoeff's and Vonkossa's method revealed intimal furrows containing parasites around which infiltration with mononuclear cells, macrophages and foam-cells were seen. Elastic degeneration accompanied by connective tissue proliferation was associated with varying degrees of calcification in the intima, and in the surrounding tissue of the parasites in media.

The Pathogenesis of atherosclerosis caused by *O. armillate* as distinct from other causes has been discussed.

28. Studies on host-specificity of Haemonchus Spp. in sheep, goats, cattle and buffaloes.

B. N. SAHAI and P. G. DEO, Izatnagar.

Investigations on the host-specificity of sheep and goat strains of Haemonchus spp. namely *contortus* and *H. bispinosus* in sheep, goats, cattle and buffaloes are reported in this paper. Experiments with goat strains of *Haemonchus. spp.* indicated that cattle were partly refractory to this infection, the percentage of development of worms being 1_36. In sheep and goats, however, the infection of this strain was found to be 8·75 per cent and 13 per cent respectively, mostly nearing the normal infection of these two species encountered under natural condition.

With the sheep strain of *Haemonchus spp.* similar results were obtained; cattle were found to develop only one per cent of infection of this strain while goats and sheep were found to develop 9·5 per cent and 10 per cent infection, respectively. The buffalo-calf was found completely refractory to the infection with this strain.

29. Studies on the efficacy of different anthelmintics against *Moniezia expansa* in sheep.

S. N. SAXENA and P. G. DEO, Izatnagar.

Investigations on the efficacy of eleven different anthelmintics against *Moniezia expansa* in sheep have been incorporated in this paper. Out of the eleven drugs tried 2% Copper sulphate in a dose of 75 c.c. per sheep and Sodium arsenate at the dose of 0·5 to 1·0 gm. per sheep have been found to be poisonous to the host. A mixture of equal parts of 2% Copper sulphate and 40% Nicotine sulphate given at the rate of 45 to 60 c.c. per sheep was 30% efficacious against *M. expansa.* Copper arsenate at the dose of 0·5 gm. per sheep, Paris green at the dose of 1·15 to 0·3 gm. per sheep were 60% and 80% effective against this worm. The latter drug proved to be 66·6% poisonous to the host. Arsenic trisulphide (yellow) at the dose of 0·5 gm. per sheep proved 75% effective in removing mature worms of this species. 25% Liquor fillicis given at the rate of 0·5 gm. in 1 oz. of castor oil per sheep did not have any action on *M. expansa,* but accelerated the rate of discharge of segments. Calcium arsenate at the dose of 0·15 to 2·0 gm. per lamb and 0·3 gm. per sheep was found to be harmless and 100% efficacious against *M. expansa.* Likewise lead arsenate at a dose of 0·5 to 1·0 gm. per sheep, Tin arsenate in the dose of 0·5 gm. per sheep, and Tin arsenite at the dose of 0·3 gm.

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per lamb were found to be harmless and 100% efficacious against the parasite. Amongst the drugs tried, Calcium arsenate was the cheapest which had 100% efficacy against worm and had no toxic effects on the host.

30. Incidence and treatment of *Dictyocaulus Filaria* (Metastrongylidae) infection among sheep and goats.

V. P. SHARMA DEORANI, Izatnagar.

Under the survey, in all 441 sheep and goats would be available for post-morten eamination. Out of 157 sheep examined, 77 (49·9%) and out of 284 goats, 32 (11·2%) were found positive for *D. filaria* infection. Sheep and goats from plains harboured only *D. filaria* while those from hills had both *D. filaria* and *V. pneumonicus*. The number of adult worms collected from individual animals varied from 2-223 in case of *D. filaria* and 3-9 in case of *V. pneumonicus*. Sheep were generally harbouring more worms than goats. The majority of worms in bronchi and broncheoles were found lying with their oral end towards the alveolar side of the air passage. The ratio of male and female worms found at different times did not vary too much. During the summer months the infection was difficult to find so much so that the experimentally infected animals became clear of infection. During spring, rainy and autumn seasons the moderately infected cases were only available. Of course, during winters there were the maximum cases of infection on record with high intensity and enough mortality. The condition of lungs examined were varying from normal to almost all degrees of consolidation, necrosis, purulation and emphysema. Oedema and damage to pleura was also not infrequent.

Three trials to assess the efficacy of Cyanacethydrazide-"Dictycide" (I.C.I.) administered subcutaneously, in the prescribed dosage schedules were conducted. The effect of the drug on three s/c injections on first, fifth and twenty-first day was not at all appreciable, either on developing or adult *D. filaria* worms, inspite of the fact that, for adults the dose was increased by one and a half times. Three injections, one on three successive days, though are more effective against both developing and adult worms, but the efficacy among adults showed only 9-21% fall in larval count, in spite of the increased dosage. There was little improvement in general health and coughing distress of experimental animals. There is slight irritation at the site of injection but is temporary. The drug is not vermicidal but if at all is only vermifugal.

31. Pathogenicity of *Dictyocaulus Filaria* infection among sheep and goats.

V. P. SHARMA DEORANI, Izatnagar.

Invariably both left and right lungs were found involved but left lung was observed to be more so. Diaphragmatic and cardiac lobes mostly contained lesions and worms, while rarely so was the case with apical lobe. Most of the lungs in early stages were showing pale emphysematous lesions, and mucous lining of the bronchioles and bronchi was inflamed, containing thin frothy exudative fluid in the air passage. In advanced cases and particularly where the infection was heavy there were observed many small or big patches of consolidation, and here the worms inside the air-passage were seen in thick and viscid mucus. On histo-pathological examination the bronchial epithelium was seen proliferated and highly infiltrated with eosinophils. For the greater part of the epithelium the ciliated

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edge of the epithelium was not intact and at many places tattering was evident with desquamation of epithelial cells. In acute cases the exudate in the air-passage was catarrhal consisting of leucocytes or epithelial cells and sometimes was fibrinous. The bronchi and bronchioles had an increase of connective tissue in their adventitial coat, and in few the wall was swollen due to much infiltration of the exudate. Sometimes the alveolar epitheliasation was more marked and the lining cells formed a sheep of cuboidal epithelium. In some lobules, the alveoli had much exudate containing neutrophils. In chronic cases, peribronchial fibrosis was also seen.

Haematological studies on six kinds, divided in three groups, and infected with 2,000, 5,000 and 10,000 larvae each, revealed that after two months of infection there was rise in leucocytic count up to 12,500-21,200 per c.mm. and the differential leucocytic count was—lymphocyte 19-55%, Neutrophils 22-41%, Eosinophils 13-31%. There was not much change in Basophil and Monocyte percentage.

32 Pathogenesis of Ogmocotyle indica (Notocotylidae) infection among sheep and goats of Uttar Pradesh Hills.

V. P. SHARMA DEORANI, Izatnagar.

In all 17 cases, positive for this infection, diagnosed by faecal examination, were examined for these studies, at Gwaldam Sheep Farm, Pauri-Garhwal (U.P.); out of which only six and two other from Chakrata hills, Dehradun (U.P.) could become available for post-mortem examination and histopathology. The symptoms begin with lassitude and depression of spirits. Appetite becomes variable and constipation alternates with diarrhoea. In a couple of days diarrhoea completely sets in. Faeces are first followed by watery diarrhic discharge, which smells very badly and is later frothy mixed with shreds of mucous sometimes with blood and rarely with pus too. Due to exhaustion the temperature may become subnormal. This condition of enteritis continues for about a week and the animal is emaciated, rises with difficulty, reluctant to move or feed and lies prostrate on the ground. For lack of nutrition the animal becomes anaemic and visible mucous membranes become pale. In later stage respirations are deep and laboured, pulse slow and weak and finally animal succumbs. Course of illness runs from 4-10 days, ending fatally or in recovery.

On post-mortem examination the gross lesions and the parasites, in varying degree, are generally found in duodenum, jejunum and ileum; and only in one case in abomasum, which was recorded by either Bhalerao (1942) or Katiyar (1956). The worms were found both attached to the wall and in the lumen of the intestine and number collected from individual animals varied from 1,900-1,02,300. The intestines were thickened, much congested and their mucous membranes rough and denuded at many places. There were linear pinpoint haemorrhagic spots throughout the infected area.

Throughout the sections the superficial mucous membrane over the villi was showing necrotic changes and marked cellular reaction. There was desquamation of mucous lining at many places. There was lymphocytic and granulocytic infiltration in mucosa and only sometimes in submucosa. In submucosa there was increase in connective tissue and blood vessels were thickened. Muscularis mucosa was damaged at some of the places. In mucosa, some sections were showing the eggs of the worm and in few their suckers were cut. In duodenum the Brunner's glands were hypertrophied and so were Pyayer's patches in the ileum. The leucocytic count was from 12,500 to 19,300 per c.mm. and the percentage of lymphocytes and eosinophils was 40-52 and 11-23 respectively.

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33. Efficacy of Trolene (Dow ET-57), Neguvon (Bayer L 13/59) and Asuntol (Bayer 21/199) against Sarcoptic Mange in goats and buffaloes.

R. P. CHAUDHURI, Izatnagar.

Treatments with trolene and neguvon at 30 mg. and 20 mg. per kg. body weight respectively orally and with asuntol and in lindane at 0·5 per cent and 0·035 per cent respectively as wash were given to goats badly affected by sarcoptic mange. Five oral dosages of trolene and neguvon although gave some relief to goats having mild scab on their bodies, did very little good to those cases where scap formation was heavy. But comparatively better result was obtained after two applications with each of the two insecticides used as wash. Thereafter the goats previously treated orally with trolene and neguvon were treated with 0·25 per cent neguvon as wash and the treatment of other goats with asuntol and lindane continued but the concentration of lindane wash was raised to 0·05 per cent. After three applications of these treatments at about weekly intervals all the goats were completely cured.

In another experiment treatments with neguvon at 0·15 per cent as wash and at 20 mg. per kg. body weight orally were given to some buffalo calves suffering from sarcoptic mange. The oral treatment was given daily for three consecutive days and after a rest for five days it was given again one day; the dermal treatment was applied twice at 5-day interval. These treatments cured the mange of the buffalo calves completely. The infection was mild and no thick scab formation took place on any of the buffalo calves treated.

34. Comparative efficacy of Sodium Sulphaquinoxaline, Sodium Sulphamezathine and Nitrofurazone 'Soluble' used as posterior prophylactics at therapeutic levels in the control of Caecal Coccidiosis *(Eimeria Tenella)* of poultry and their effect on the development of immunity to the infection.

B. S. GILL, M. N. MALHOTRA and N. B. LALL, Izatnagar.

A series of 8 trials were undertaken to evaluate the efficacy of sodium salts of sulphaquinoxaline (0·05%) and sulphamezathine (0·2%) and nitrofurazone 'soluble' (0·011% and 0·022%) administered in drinking water from 0 hour to 72 hours after infection in controlling severe, experimentally induced *Eimeria tenella* infection of 3—4 weeks old susceptible W.L.H. chicks, and also to find out the effect of such treatments upon the development of immunity to the parasite.

The pooled data revealed that treatment imitiated before the infection was 48 hours old, offered complete protection except 0·011 per cent nitrofurazone in which case heavy mortality and bleeding also occurred in chicks treated since 24th hour. Thereafter the efficiency of all the coccidiostats decreased progressively. Sulphamezathine proved the best and sulphaquinoxaline and nitrofurazone (0·022%) were about equally effective. Treatments given simultaneously with the infection and 24 hours after, interfered with the development of immunity to the infection.

35. Studies on the comparative efficacy of Sodium Sulphaquinoxaline, Sodium Sulphamezathine and Nitrofurazone 'Soluble' in the control of Caecal Coccidiosis *(Eimeria Tenell)* of poultry.

B. S. GILL, M. N. MALHOTRA and N. B. LALL, Izatnagar.

A series of eight experiments were undertaken on the comparative efficacy of sodium salts of sulphamezathine (0·2%) and sulphaquinoxaline (0·05%), and nitrofurazone 'soluble' (0·011% and 0·022%) in controlling artificially-induced and clini-

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cally-evident *Eimeria tenella* infection of susceptible chicks. Medication began immediately on the appearance of blood in faeces. The drugs were administered in drinking water, the sulphonamides according to 3-2-3 interrupted schedule and nitrofurazone for 7 days continuously. Pooled data showed that whereas 76·5% of control (untreated) chicks died of the infection, only 31·8, 46·9, 49·7 and 50 percent chicks treated with sulphamezathine, sulphaquinoxaline and nitrofurazone on lo and high levels, respectively, died. Treatment though reduced mortality considerably but did not affect bleeding which was of the same degree in the variously treated groups. Use of coccidiostats did not interfere with the development of immunity to the parasite.

36. Some observations on the incidence and biology of *Monaxi a* species in sheep and goats with a note on the pathogenesis of *Moniezaiez apnse* in sheep.

S. N. SAXENA and P. G. DEO, Izatnagar.

The results incorporated in this paper showed that the incidence of *Moniezia* species in sheep and goats at Bareilly was 28% and 22% respectively. The infection of *M. expansa* in sheep and goats was found to be 15% and 4%, while that of *M. benedeni* was observed to be 0·7% and 10·7% respectively. There was no correlation between the number of *M. expansa* present and the discharge of their segments in the faeces of sheep. There was no effect of starvation on the removal of *Moniezia expansa* in sheep. The discharge of segments was accelerated as the period of starvation of the host was progressively increased. Histopathology of *Moniezia expansa* in sheep has been studied. The mortality rate due to the infection of this parasite in sheep and lambs was found to be as high as 24 percent.

37. On the role of the Stable Fly *Stomoxys Calci rans* L. in the transmission of Surra in this country.

R. P. CHAUDHURI and PAVAN KUMAR, Izatnagar.

Transmission experiments were carried out to study the role of the stable fly *Stomoxys, Calcitrans* in the transmission of surra amongst livestock in this country. Guineapigs, dogs and ponies were to be used as experimental animals in this study. Thirteen experiments on guineapigs and four on dogs had so far been carried out.

Though in some experiments more than a hundred stable flies had been tried in each case only five to forty of them fed on the experimental animals. Flies were first allowed to feed for ½ minute to 3·½ minutes on the surra affected animals before transferring them to the healthy experimental animals for feeding for ½ min. to 5 min. Feedings were done under close observation using one fly at a time. After the transmission feedings were over the experimental healthy animals were maintained under observation at least for a month.

Thirteen experiments on guineapigs and four on dogs had so far been carried out, of these one experiment with guineapigs and one with dogs had been found to have given positive result. The study is in progress.

38. Selection of pullets on the basis of width of the back at the time of sexual maturity.

H. P. TANDON, S. P. SETHI and S. BOSE, Izatnagar.

Studies have been undertaken to find out the variations in the maximum width of the back of S. C. White Leghorn pullets and their relationship with sexual

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maturity and egg production to end of March. Observations were made on 128 pullets. The maximum width of the back ranged between 7·5 cm. and 11·0 cm. 68·7% of the pullets fell within the range of 8·6 cm. to 9·5 cm. 14·1% below 8·6 cm. and 17·2% above 9·5 cm.

Pullets having relatively narrower backs, maximum width 8·8 cm. or below, matured, on an average, earlier than those having wider backs. The differences in respect of mean age at 1st egg between various classes of pullets grouped on the basis of maximum width of the back were, however, non-significant. It seems that little or no relationship exists between width of the back and sexual maturity. As regards egg production to end of March, pullets having relatively narrower backs, maximum width 8·5 cm. or below, gave the lowest production. The difference in mean egg production of the various classes of pullets, grouped on the basis of maximum width of the back, were non-significant. The results, however, indicate that pullets having maximum width of the back less than 8·6 cm. on the day of 1st egg should preferably not be selected for the purposes of winter egg production.

39. Selection of pullets on the basis of body weight at sexual maturity.

H. P. TANDON, G. V. RAO and S. BOSE, Izatnagar.

Studies were undertaken to find out the variability that exists in the body weight at 1st egg in White Leghorn pullets and its relation with age at 1st egg and winter egg production.

Observations were initiated on 209 pullets. Body weight at 1st egg ranged from a minimum of 1080 gms. to a maximum of 2588 grams with a standard deviation of 220·4 grams. 81·8% of the pullets fell within the range of 1301 to 1900 grams.

Lighter pullets matured earlier than the heavier ones and a positive correlation of 0·40 was obtained between age at 1st egg. and weight at 1st egg.

Differences in respect of winter egg production (till the end of March) between pullets of lighter and heavier body weight groups were non-significant. A negative correlation of −0·2 was obtained between weight at 1st egg and winter egg production.

40. Record of Individual Hen's Egg Production without Trapnesting.

R. B. L. SRIVASTAVA and S. BOSE, Izatnagar.

Trapnesting though used all over the world for measuring individual hen's egg production, is not practised by the average Indian Poultry Keepers, as owing to its limitations, it does not suit the village conditions.

Experiment was, therefore, conducted to standardise a method of recording individual hen's egg production by palpation without the use of trapnests. Eggs were felt by palpating over the abdominal region by the tip of the fingers and most of the hens which were found positive in the morning, laid during the day excepting a few which carried eggs over to the next day. When hens were handled early in the morning and leg band numbers of those found positive noted, the number of eggs found during the day usually tallied with the number of birds found positive in the morning. In cases where the number of eggs were less, the hens which did not lay could be detected by palpating in the evening. The remaining hens were then credited with one egg each. This simple method can very easily be used by the village poultry keepers for recording individual hen's egg production.

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41. Studies on the histopathology of Avian Spirochaetosis.

V. V. SRINIVASAN, Izatnagar.

Spirochaetosis is an important septicaemi cdisease caused by Borrelia anserina (Spirochaeta gallinarum) and is characterised by high morbidity and mortality.

A review of current literature on the histopathological studies of spirochaetosis, indicates that much work has been done only on Turkeys and there is lack of information on the microscopical changes of the affected tissues of fowls suffering from the disease. This prompted the author to undertake the investigation. Studies on the histopathological changes of spleen, liver, lungs, kidney, intestines, heart and brain of birds died 72-90 hours after artificial infection were made and the findings have been presented in this paper.

The myocardial fibres showed extensive degenerative changes with increased granularity. The spleen showed distinct hyperplasia of reticular cells in the malphigian corpuscles with the formation of reaction centre The liver revealed marked dissociation of hepatic cords and consequent potency of the sinusoids which were infiltrated with heterophiles. The lungs showed foci of atelectasis and consolidation. The kidney depicted a picture of subacute glomerulo-nephritis. The intestines did not show much appreciable changes except for the disorganisation of the epithelial cells. The brain showed degenerative changes in the neurons.

Further studies are also being made to find out if there are differences in tissue changes by different strain at various intervals.

42. The Histopathological studies of Chronic Respiratory disease in Fowls.

V. V. SRINIVASAN and S. B. V. RAO, Izatnagar.

In the beginning of the year 1961, an outbreak of Chronic Respiratory Disease occurred in the growing stock of chickens of the Indian Veterinary Research Institute Poultry Farm, in which pathogenic pleuro-pneumonia-like organisms were incriminated as the sole cause of the disease. Since the lesions mainly involved the trachea, lungs and airsacs, the histopathological studies were confined to these organs.

Studies of the affected tissues of the birds in both natural and artificially infected cases, have been made and a detailed description has been presented in this paper.

The trachea revealed a picture of acute catarrhal tracheitis with lymphofollicular hyperplasia. The lungs showed, in rare cases, some changes associated with bronchopneumonia. The lamina propria of the airsac was thickened with serous exudate. The infiltration of the mononuclear cells was observed at scattered areas.

In cases of birds artificially infected, the changes were not so pronounced as observed in the natural cases. The changes were, however, more inflammatory in nature.

The histopathological findings of the authors did not differ much from that of the workers abroad, who have studied this aspect of the disease as well.

43. Studies on the Immunization of day old chicks against Fowl pox with Fowl pox Virus modified by serial passage in duck embryos.

S. B. V. RAO and K. K. AGARWAL, Izatnagar.

Fowl pox embryonated Vaccine Virus (F.P.V.) Rao's strain was serially passaged in duck embryos with a view to attenuate its virulence for immunising day old

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chicks. The F.P.V. was adapted to the Chorio-allantoic membrane (CAM) of the duck embryos after twenty serial passages resulting in takes in the form discrete plaques spreading over the entire area of the CAM which became highly oedematous. Preliminary trials at immunization of day old chicks with duck-embryo-modified FPV at the twentieth passage level with a 5 per cent suspension of the infected CAM in glycerine/saline by wing-web puncture as well as by follicular method gave satisfactory takes without metastatic lesions, generalization or systemic reaction of any type. All the vaccinated chickens were refractory to challenge with Virulent fowl pox Virus for four months after vaccination up to which time the monthly tests were conducted. Further immunity trials are under progress.

44. Studies on Chronic Respiratory Disease of chickens in India. Part I. The isolation and identification of a pathogenic strain of PPLO (Mycoplasma gallinarum).

P. G. PANDE, S. B. V. RAO and K. K. AGARWAL, Izatnagar.

The occurrence of an outbreak of respiratory disease on a large North Indian farm is described in a flock of 3,000 growing chickens. The disease involved both the upper and lower respiratory passages. Over a 1,000 birds were affected and about forty per cent succumbed. But the morbidity was more marked than mortality. The symptoms were, rhinitis, sinusitis, laryngitis, respiratory distress resulting in audible rales and grasping, oedema of face and conjunctivitis, tracheitis, aero-cystitis, pneumonitis, and marked thickening of the air sac membranes. Yellow cheesy exudate was observed in the trachea and air-sacs, while hyperplasia of the tracheal mucosa, representing lympho-follicular reaction was observed in sections. Pleuro-pneumonia like organisms were isolated in PPLO (modified Grumbles) media, and in embryos. They were classified according to Sabin's criteria (1941) as PPLO. Colonies grew in enriched serum agar plates inside the media, and morphologically confired to the pattern described by Chu (1958). The organisms produced identical disease in 13 to 18 days in 100 per cent of the susceptible chickens obtained from a flock unexposed to the disease.

Pathogenic PPLO were similarly isolated from heavy mortality from week-old brooder chicks on the same farm with lesions of congested trachea suggestive of an egg borne nature of the disease.

Chemotherapy with a certain combination of antibiotics has given encouraging results.

45. Influence of feeding urea as a partial protein substitute on milk yield and butter fat production in buffaloes.

P. C. SAWHNEY and S. C. GUPTA, Izatnagar.

Sixteen buffaloes of about the same age and general condition were selected from the Institute Dairy and divided into four groups of four each on the basis of their lactation number, days in milk and average milk yield. Treatments were offered at random, which comprised of one control and three experimental. In the experimental groups, 10, 20 and 30% of the digestible crude protein requirement of the animals was met by urea. The animals in control group received dairy mixture and wheat *bhoosa* (*ad lib.*) as roughage, whereas, in the experimental ones, the alloted requirement of protein was met by urea and the rest by dairy mixture. Each experimental group ration was made isocaloric with that of control by the addition of requisite amounts of starch, and, in addition, each animal was offered one ounce of dairy mineral mixture supplement every day. Greens were

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fed during the available season after making necessary deductions from the dairy mixture for its protein content. The maintenance ration was kept constant and the ration for milk production was changed at fortnightly intervals depending upon the milk production and butter fat percentage of the animals.

Feeding on the above pattern was continued for a period of full one lactation. The milk yield of each animal was recorded, both for morning and evening, every day and the fat percentage was determined twice a week.

The first 24 weeks' data of total milk yield, butter fat produced and fat corrected milk (corrected up to 4% fat), when subjected to analysis of variance, did not indicate any significant difference in between the groups in all the three cases. The average respective (Control, 10% D.C.P. replacement level, 20% and 30%) group-size figures were : 2024·50, 1966·25, 1957·75 and 1979·75 lb. (with a standard error of ±153·0) ; 138·70, 130·11, 131·08 and 130·82 lb. (with a standard error of ±14·44), and 2888·75, 2734·50, 2749·00 and 2746·00 lb. (with a standaard error of ±179·0) for total milk yield, butter fat produced and fat corrected milk (to 4% fat) respectively.

46. Urea enriched Sugarcane Bagasse as cattle feed.

V. MAHADEVAN, M. M. JAYAL and P. S. GUPTA, Izatnagar.

A cattle-feed-mixture with 50% sugarcane bagasse, 20% wheat *bhoosa,* 20% wheat bran, 5% molasses, 2% urea, 2% mineral mixture and 1% salt was prepared which gave the following percentage chemical composition :

C.P., 11·56; E.E., 1·23; C.F., 35·68; N.F.E., 43·75; Ash, 7·78; Calcium (Ca), 0·52 and phosphorus (P), 0·48.

For conducting a feeding trial the cattle-feed-mixture was fed *ad lib.* to three *Hariana* bullocks for 30 days. Each animal was given 1 kg. of green berseem daily. A metabolism trial was conducted during the last 10 days.

The experimental animals on an average, consumed 1·46 kg. of the total ration on dry basis, per 100 kg. body weight per day.

The average digestibility coefficients of the feed-mixture were : C.P., 75·00; E.E., 69·35; C.F., 49·41 and N.F.E., 53·37. The D.C.P. and T.D.N. values in kg. per 100 kg. of the feed-mixture, on dry basis were 8·67 and 51·57 respectively. The animals maintained positive balance for nitrogen, calcium and phosphorus.

47. Effect of feeding urea as a partial protein substitute on the digestibility and metabolism of milch buffaloes.

P. C. SAWHNEY and S. C. BISARYA, Izatnagar.

Twelve buffaloes at post-peak lactation were divided into four groups of three each on the basis of their milk yield, butter fat percentage, lactation number, days in milk, live weight and breed. The four groups were offered four different treatments, i.e., one as control and the other three receiving 10, 20 and 30 per cent of the digestible crude protein requirements by urea, at random. The control group was maintained on the normal dairy mixture plus wheat *bhoosa ad lib.* as roughage, whereas, in the other three groups, alloted requirements of proteins was met by urea and the rest by dairy mixture. Wheat *bhoosa* was offered *ad lib.* as roughage. Rations in the experimental group were made isocaloric as compared to control by the addition of requisite amounts of starch. The above ration was adequately supplemented with common salt, dairy mineral mixture and vitamin A.

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After a preliminary feeding of 12 weeks, a metabolism trial lasting for 10 days was conducted. The average digestibilities of crude protein, ether extract, crude fibre and nitrogen-free-extract were found to be 53·4, 56·0, 56·0 and 56·0; 69·3, 44·0, 45·9 and 49·3; 58·5, 61·3, 57·5 and 51·6, and 55·1, 59·0, 59·4 and 63·9, respectively for the group serving as control and others receiving urea at 10, 20 and 30% of the animals' D.C.P. requirements, respectively. The balances of nitrogen and minerals were positive in all the groups, on the average and dry matter and total digestible nutrients, ingestion per 100 lb. live weight were 1061·3, 1064·7, 1145·9 and 1136·2 gms. and 557·3, 582·5, 619·0 and 623·3 gms. respectively in the four groups.

From the above observations, it will be seen that, with the exception of the average digestibility of figures for ether extract; the other characters have little, if any, difference in between the groups. In the case of ether extract, the variation in digestibility figures might have been partly due to the lowered ingestion of ether extract from the dairy mixture in the experimental groups.

48. Clinical Syndromes and Histopathological changes in Natural cases of Vitamin 'A' deficiency in Cow Calves.

BRAHM DUTT and B. VASUDEVAN, Izatnagar.

Vitamin 'A' deficiency causes a variety of clinical and pathological lesions in different species of animals. The only common clinical symptom in vitamin 'A' deficient animals is night blindness.

A few clinical cases of vitamin 'A' deficiency in calves were observed in the dairy herd of the Indian Veterinary Research Institute, Izatnagar. The calves showed opacity and ulceration of cornea, rough coat and had frequent attacks of diarrhoea and convulsions. The calves were completely blind. Histopathological studies of the tissues obtained from the two vitamin 'A' deficient calves revealed that the pseudo-columnar epithelium of the interlobular ducts of the parotid gland had been replaced by multilayered stratified squamous epithelium. The histological changes in other tissues were just non-specific associated with inanition. The parotid gland in bovine is therefore the only tissue which shows pathognomonic changes of metaplasia in vitamin 'A' deficiency.

49. A clinical case of hypothyroidism in a ram.

B. DUTT and B. VASUDEVAN, Izatnagar.

One ram of the Animal Nutrition Division was seen to be going down in condition progressively. The clinical symptoms shown by the ram could not be associated with any bacterial or viral infection. Supplementation of the diet with trace minerals and vitamin (A, D and E) proved unavailing. Deworming of the lamb for possible helminthic infection had also no effect.

The ram on autopsy showed a cystic thyroid gland with a very thin and atrophied parenchyma enclosing the cyst.

On histological examination, the thyroid revealed big cysts containing colloid material bordered by a thick capsule. The parenchyma bordering the cysts was atrophied and replaced by fibrous tissue. The acini, a little away from the cyst wall were also atrophied and separated by myxomatous tissue. Histological examination of testes showed absence of spermatogenesis. The pituitary gland showed hyperplasia of basophil cells.

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50. Influence of Copper and Cobalt Supplementation on the Growth of Hariana Calves.

V. S. BISARIA and V. MAHADEVAN, Izatnagar.

Three groups of young calves aged about 2 months eight in each group consisting of four females and four males, have been grouped at random taking the age and body weight into consideration. All the calves were given a basal ration consisting of what *bhoosa*, greens and calf mixture which is composed of 40 parts wheat bran, 30 parts ground nut cake and 30 parts of barley. The ration was rendered adequate in all respects by feeeding required amounts of vitamins A, D and E, 14 gm. dicalcium phosphate, 14 gms. salt and the D.C.P. and T.D.N. were adequately met with according to Sen's feeding standard. The control group received the basal ration only, while the 2nd group received the basal ration and 6·3 mgm. of Cu and 0·05 mgm. of Cobalt as copper sulphate and cobalt chloride respectively. The third group received only 6·3 mgm. of Cu as supplement as copper sulphate. The levels of supplement continued to be the same throughout the experimental period from 2 months of age to one year.

Weekly body weights of the calves have been recorded, and adjustments were made in the calf mixture ration for each animal to supply the required levels of D.C.P. and T.D.N.

The control growth rate per week for 80 kg. body weight in all the groups were 1·45 kg. for control, 1·57 kg. for cobalt and copper supplemented group and 1·43 kg. for copper supplement group. Copper and Cobalt supplementation has surpassed all the other two groups in the growth rate during a period of 10 months. In the copper supplemented group even though the growth rate was not exceeding the copper and cobalt supplemented group, it was better than the control group.

When the growth rate is estimated up to 6 months of age the growth rate trend observed was highly significant. The corrected growth rate in the case of Cu and Co group as well as Cu group alone as compared with that of the control for 48 kg./week was 1·29 kg. for control, 2·24 kg. for copper and cobalt group and 1·62 kg. for copper supplemented group.

Copper and cobalt supplementation at the above levels influence a better growth rate than copper alone in young growing calves even though the ration used is not deficient in copper and cobalt.

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SECTION OF AGRICULTURAL SCIENCES

President :—PROF. P. K. SEN, M.Sc., Ph.D. (Lond.), D.I.C., F.B.S.

Abstracts.

AGRONOMY

1. Assessment of water for irrigation from climatological data.

A. P. BHATTACHARYA, Roorkee.

Water requirements of three principal crops of Uttar Pradesh, namely, wheat, rice and sugarcane, are under experimentation at a number of stations in U.P. ever since 1942-43. A number of standard formulae, utilizing climatological data alone were tested against the experimental results to provide a check-up. This year, only the observational data for wheat at Dhanauri (near Roorkee) for the years 1956-57, 1957-58 and 1960-61 was utilised in this approach.

Lowry-Johnson method, evolved by the United States Bureau of Reclamation, using the accumulated heat or effective day degrees (accumulated maximum temperatures in °F above 32° F during the growing season), gave quite high figures.

The best method was found to be that advocated by H. F. Blaney of the United States Department of Agriculture in view of the close analogy of the theoretical figure of 8·31 inches with the experimental result of 8·50 inches, besides its simplicity.

Excellent fit was also obtained with the Penman formula, evolved by Dr. H. L. Penman of the Rothamsted Experimental Station, but the calculations were lengthy. Based on this, the results of the Van Bavel (of the Virginia Experimental Station, U.S.A.) formula also gave reliable results.

The fit obtained by the Hargreaves formula was satisfactory. Figures obtained on the basis of the Thornthwaite formula were rather high.

2. Study of the response of rice to different levels of organic manures and inorganic fertiliser.

B. N. SAHU, Bhubaneswar.

For getting information on the relative value of Organic manures such as Green manure, Oilcake and Farmyard manure and Inorganic fertiliser alone and in combination on the productivity of rice soils, a field experiment has been laid down in Agronomy section of the State Agricultural Research Station, Bhubaneswar, Orissa since the year 1956-57. The experiment has been laid out in a split-plot design; the organic manures have been applied in the main plots and the levels of Nitrogen in the sub-plots, the organic manures tried are Farmyard manure, Green manure with Sanhemp and groundnut oilcake to supply 40 lbs. Nitrogen per acre while the Inorganic fertiliser is being applied as Ammonium sulphate to supply 20, 40, 60 and 80 lbs. Nitrogen per acre. There is one No manure plot both in the main and sub-plot treatment as control. The experiment has been laid out in 4 replications with twenty plots in each. A long duration Paddy variety T90 is being grown every year. The experiment is being continued at the same site without any change in randomisation. The paper presents the results obtained during the seasons 1956-57 to 1960-61.

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The results indicate that the control plot has given the lowest yield, 1,732 lbs. per acre, whereas all Organic manures have given an appreciable increase in yield.

There does not appear to be very much difference due to the application of Farmyard manure and groundnut oilcake.

Farmyard manure has given lower yield than that of green manure. The great variability in the composition of bulky and semibulky manures has to be taken into consideration while assessing their effect on the yield and their relative efficiency.

Amongst all levels of Nitrogen applied as Ammonium Sulphate alone, maximum yield of 1,913 lbs. has been obtained at 60 lbs. per acre and thereafter the yield decreases.

There seems to be positive reaction between Farmyard manure and green manure with Ammonium sulphate. Highest yield has been obtained with 40 lbs. of Ammonium sulphate superimposed over a basal dressing of 40 lbs. Nitrogen as farmyard manure.

Groundnut oilcake when applied alone @ 40 lbs. Nitrogen per acre has given a yield of 1,865 lbs. of grain per acre whereas the yield decreases when Ammonium sulphate is superimposed at the graded dose. The interaction is therefore negative.

On the basis of the above experimental data it is seen that maximum yield of paddy can be obtained either by application of Farmyard manure to supply 40 lbs. of Nitrogen followed by 40 lbs. Nitrogen as Ammonium Sulphate or by green manuring with Sanhemp so as to supply 40 lbs. Nitrogen supplemented by application of 40 lbs. of Nitrogen as Ammonium Sulphate.

3. Efficiency of different nitrogenous fertilizers for rice production in laterite soils of Orissa.

I. C. MAHAPATRA and B. N. SAHU, Cuttack.

Field experiments are in progress at the Agronomy Section of the State Agricultural Research Station, Orissa since 1955-56 to study the relative efficiency of different nitrogenous fertilizers for rice crop in acidic sandy loam laterite soils of Bhubaneswar @ 20, 40 and 60 lbs. N. per acre in the forms of Ammonium Sulphate, Ammonium Chloride, Urea, Ammonium Sulphate Nitrate and Calcium Ammonium Nitrate. A long duration variety, T. 1242 (160 days duration) was grown in the experiment. The results of the first four years, 1955-56 to 1958-59, are discussed.

The results revealed that application of all fertilizers tried gave a substantial increase in rice yield. Ammonium Sulphate is the most efficient fertilizer among the five forms tried, but there were no significant differences among them. The relative ratings of Ammonium Sulphate Nitrate, Ammonium Chloride, Calcium Ammonium Nitrate and Urea are 99·24, 94·96, 93·81 and 92·18 respectively taking Ammonium Sulphate as 100. The grain yield response is linear upto 60 lbs. N. per acre. There is differential response due to season in case of most of the fertilizers. Ammonium sulphate gave maximum yield of 2369 lbs. per acre at 40 lbs. N. level while rest of the fertilizers yielded their maximum at 60 lbs. N. per acre. All the five forms tried could be used as alternate fertilizers, the selection of which will be determined by the cost per lb. of nitrogen.

4. Chemical weed control in Wheat and Paddy fields.

A. P. MANI, Kerala State.

Detailed investigations on field scale in replicated blocks have been carried out in the Shyamnagar Farm of the Bose Institute on the feasibility and effectiveness of chemical herbicides such as Cornox-M, Fernoxone and Crag Herbicide-1 in con-

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trolling weeds in wheat and paddy fields, the data in every case being statistically analysed.

The appropriate time of application of herbicides in a standing crop and its implications have been clearly brought out. However, the necessity of taking into account the nature of weed growth in fixing the time of treatment is also clearly indicated.

The optimum dosage of Crag Herbicide-1 which can be recommended for weed control in wheat and paddy fields has been found to be 5 lbs. per acre. In addition to the effective control of weeds, treatment with "Crag" has produced an increase in yield over the manually weeded control in paddy.

A comparative study of Cornox-M and Fernoxone in wheat and paddy fields has shown that the latter is a better herbicide in both the crops. Treatment with Fernoxone has yielded as good a result as manually weeded control in wheat crop.

The problem of eradication of noxious weeds such as *Cyperus rotundus* and *Cynodon dactylon* has been fully discussed and it has been shown that by a timely and judicious application of Fernoxone both the weeds can be controlled in paddy and wheat fields with a fair degree of satisfaction without harmful effects to the standing crops.

The economics of chemical weed control has been worked out in both the crops. It has been found that chemical weed control is more economical and efficient than manual weeding. However, the necessity of producing cheaper chemicals or making them available to the cultivator at subsidised rate has been indicated.

5. Tillage experiment on rice : Study of the comparative efficiency of different tillage practices with an iron and country plough on the yield of rice.

B. N. SAHU, Bhubaneswar.

In the 'dry' and 'semi-dry' systems of cultivation of rice in Orissa, number of ploughing is given in Summer with a country plough for obtaining a good tilth. In the 'Wet system' the field is puddled by repeatedly ploughing three or four times with an interval of about four days between each ploughing and levelled before transplanting. For getting information on the relative value of preparing land with an Iron plough and country plough and ploughing in different months a field experiment was laid out in the Agronomy Section of the State Agricultural Research Station, Bhubaneswar, Orissa. The experiment was laid out in a split plot design in three replications having twelve plots in each block, ploughing with an Iron plough and Country plough in the main plot and the ploughing as per the schedule indicated below in the sub-plots.

Mainplot Treatment :

(i) Ploughing with Iron plough.
(ii) Ploughing with Country plough.

Sub-plot Treatments :

(1) Ploughing once in every month after harvest of the previous crop.
(2) Ploughing in every alternate month (3 ploughings).
(3) Ploughing once in every third month.
(4) Fallow till July, puddling and transplanting.
(5) Fallow till August, puddling and transplanting.
(6) Normal practice or ploughing in January after the harvest of the previous crop, puddled and transplanting in July (Control).

A long duration paddy variety T. 1242 was grown in the experiment. The experiment is being conducted in the same site without any change in the randomi-

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sation of treatments. The paper presents the results obtained during the seasons 1959-60 and 1960-61.

The yield data indicate that (1) ploughing and puddling with Iron plough is superior to that with country plough, (2) in the 'Wet system' of rice cultivation ploughing and puddling the field in July and transplanting rice is superior to any other system of ploughing and preparation of land.

6. Seasonal variations in growth and yield of Aus, Aman and Boro paddy.

B. N. GHOSH, Chinsurah.

Three varieties of aus paddy : Kele, Jhanji-34 and Satika; three varieties of aman paddy : Badkalamkati-65, Rupsail and Latisail, and four varieties of boro : Chinsurah boro-1, Chinsurah boro-2, Jagal-IX and Bhogjira-III, were grown in the Kharif (wet) and boro (dry) seasons to study the seasonal effects on the growth and yield. The experiment was laid out in randomised blocks with four replications.

The height of the plant and the length and breadth of the flag leaf became shorter during the boro season than when grown during kharif, irrespective of aus, aman and boro. However, the reverse is the case in respect of tillers, i.e., more number of tillers were produced during boro. It seems that high temperature, high percentage of relative humidity, more rainfall and less hours of bright sunshine are favourable weather factors for height of the plant and length and breadth of the flag leaf, whereas the reverse is true in respect of tillers, i.e., low temperature, less rainfall, low percentage of relative humidity and more hours of bright sunshine are essential climatic factors for the production of tillers.

The length of earheads became shorter in all the varieties in boro season, except in Satika and in aman varieties, particularly in Badkalamkati-65, where an appreciable increase was recorded.

Early flowering was observed in boro varieties when grown during kharif and that of aus varieties became late when grown during boro and vice versa. Regarding aman varieties, they took a much longer time to flower during kharif, but flowered almost simultaneously with those of aus and boro during the boro season, thereby indicating that the ear emergence of these varieties of aus, aman and boro begins at the time when the day-length is between 11·32 and 12·58 hours, irrespective of the season.

All the varieties gave significantly larger yields of grain and straw in the boro season, except Rupsail, in comparison to the grain and straw yields in kharif. An appreciable increase is noticed in Jhanji-34, Satika, Latisail, Badkalamkati-65, Chinsurah boro-1, Chinsurah boro-2 and Jagal-IX. This indicates a preference of the paddy varieties, irrespective of aus, aman and boro, for dry season when temperature and bright sunshine hours are high and plenty with less rainfall and low percentage of relative humidity during the flowering and grain formation period.

From the above result, it can be concluded that Latisail and Badkalamkati-65 (both aman) can be successfully grown twice a year during the kharif and boro seasons along with suitable varieties of aus and boro. Further studies with other aman varieties are in progress.

7. Chemical composition of different types of tobacco grown on goradu soil.

K. A. PATEL and B. V. MEHTA, Anand.

Chemical composition of different types of tobacco viz., bidi type (K-49, K-20, S-12, S-20, G-6 and Sokhadiu), chewing type (P-90, P-98, P-4 and S-57), higher grade

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cigarette type (Delcrest, Chatham, Harrison Special, Hicks Special and Virginia Gold), lower grade cigarette type (Dumbara and G.F.T_2) and hookah and snuff types (Raskaliu and Calcuttia) grown on *goradu* soil of Anand by the standard methods, was studied by determining important constituents such as nitrogen, nicotine, total sugars, starch, wax-resins, total volatile bases, volatile oil, ash, acid-soluble mineral matter, calcium, magnesium, potassium, phosphorus, sulphur and chloride. From the results obtained it is concluded that the different types of tobacco have the following characteristics :—

Bidi tobacco :—high nitrogen, nicotine, total volatile bases, wax-resins, volatile oil and low total sugars contents. Chewing tobacco :—high nitrogen, total volatile bases, wax-resins, volatile oil, calcium, chloride, fairly high nicotine and low total sugars contents. Higher grade cigarette tobacco :—high total sugars and low nitrogen, nicotine, wax-resins, total volatile bases, volatile oil, calcium and chloride contents. Lower grade cigarette tobacco :—fairly high nitrogen, nicotine, total sugars and volatile oil and low wax resins and chloride contents. Hookah and snuff tobacco :—high nitrogen, nicotine, total volatile bases, wax-resins, volatile oil and chloride and low total sugars contents.

8. Expected leaf-burn order of different varieties of tobacco from their chemical composition.

K. A. PATEL and B. V. MEHTA, Anand.

In case of smoked tobacco, the ability of the leaf to burn is an important criterion of the quality. It is recognised that there is a favourable influence of potassium and unfavourable influence of chloride and nitrogen on leaf burn. Sastry and Kurup obtained a positive correlation between leaf-burn and the ratio $\frac{K_2O}{N+Cl}$. In the present study the expected leaf-burn order of 15 different varieties of tobacco grown on *goradu* soil has been worked from the chemical composition by calculating the ratio $\frac{K_2O}{N+Cl}$. The decreasing order of leaf-burn is :—higher grade cigarette>lower grade cigarette>bidi type>hookah type. Among higher grade cigarette varieties, Harrison Special and Virginia Gold are at the top. Among bidi varieties, the Nipani variety S-20 has better burning quality than the two Gujarat varieties K-49 and K20.

9. The performance of some newly introduced varieties of flue-cured tobacco with special reference to qualities of commercial importance.

G. S. MURTY, Rajahmundry.

The paper deals with the comparative performance of a number of flue-cured varieties that have been recently introduced into India by the Central Tobacco Research Institute, Rajahmundry. The varieties were tested in replicated trials at the Institute's Farm at Katheru during 1960-61. The data indicated that a variety's potential to produce top grades does not really depend upon its capacity to produce a high green leaf yield. Thus, Hicks, which is a poor performer in so far as green leaf yield is concerned, is the most promising variety in regard to bright grades and Total Bright Leaf Equivalent. As quality is the chief criterion to assess a variety in flue-cured Virginia types, it can safely be said that Hicks is about the best variety amongst all the varieties tested. It has the best bright grades and Total Bright Leaf Equivalent in spite of the fact that the total green leaf yield it produced did not match with other varieties. It is encouraging to note that its performance has been consistently good even when compared to last year's results.

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White Gold, which had the poorest performance so far as the green leaf yield is concerned, ranked next only to Hicks in its bright leaf yield and Total Bright Leaf Equivalent, while Putcha, a variety which is not well favoured by the trade, in spite of producing a very high green leaf yield revealed its incapacity to produce a correspondingly higher yield in bright grades and Total Bright Leaf Equivalent.

In such of those varieties where the green leaf yield was significantly high, yet the final Total Bright Leaf Equivalent was poor, it is to be presumed that the variety produces a high proportion of low grades. To this category belong such varieties as R. 21 and H. a. Karedu, a 'mongrel' type, appears to have a uniform performance in all the four categories of assessment. The keeping quality of Karedu is rather poor and it is known to fade in colour. But for this handicap it is a variety to reckon with.

The synthetic types S.A. 40-31 and 40-15 are potentially good varieties as the data indicate. However, their leaves are poor in texture and body and if improvement is effected in this direction the varieties promise to stand comparison with Delcrest—the variety generally accepted by the trade at present. Planned hybridization programmes are already under way in this direction.

The varieties Bissettes and Putcha showed negative response to topping in respect of total green leaf yield. Harrison Special, Chatham and Virginia Bright showed negative response to topping for cured leaf. Super Gold and S.A. 40-18 had negative response for Total Bright Leaf Equivalent. The varieties that gave the best response to topping were D.B. 244 for green leaf, Harrison Special and R. 21 for cured leaf, and Bottom Special and Vamorr-50 for Total Bright Leaf Equivalent.

10. Effect of cultural treatments on the carbohydrate content at different stages of growth of Pachyrhizus angulatus tubers.

B. PARIJA and P. C. PARICHA, Bhubaneswar.

An experimental investigation on the tubers of *Pachyrhizus angulatus*, Rich. was undertaken to find out the carbohydrate changes, the trend of growth during tuber development and the influence of cultural treatments on the carbohydrate fractions at maturity.

A randomized block design with four replications was adopted for the cultural treatments : (i) growing the plants in flat beds, (ii) growing the plants in the ridges, (iii) staking the plants and (iv) non-staking.

The glucose content increased slowly up to the second month and it maintained a steady value thereafter. Reducing sugars at this stage seemed of no importance except to maintain a steady supply for oxidation. The sucrose content, except in the initial stages, was higher than that of glucose throughout. The maximum percentage of glucose was 2·4 and that of sucrose was 3·0, at the end of the second month. Starch content rose steadily to a maximum of 6·9 per cent. The decrease in sucrose coincided with the increase in starch indicating the possibility of conversion from one form to the other. The dry matter increased progressively. Starch content in the tubers grown in flat beds without staking was significantly higher possibly due to less destruction in the tubers or greater translocation into the tubers.

AGRICULTURAL CHEMISTRY

11. Distribution of cobalt in some typical profiles of Gujarat.

K. G. REDDY and B. V. MEHTA, Anand.

Cobalt has assumed importance in agriculture because of the relationship between the cobalt content of fodders and animal nutrition. Cobalt is accumulated

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from soils by plants which in turn become the primary source of cobalt for animals. From the available cobalt contents of 48 representative surface soils of Gujarat it was found that about one-third of the soils contained less available cobalt than necessary for growing pastures suitable for the normal health of cattle. As deep-rooted crops get nutrition from the sub-soil also, it was thought useful to assess the cobalt status of six soil profiles of Gujarat viz. (1) *goradu* soil of Anand (Kaira), (2) medium black soil of Chharodi (Ahmedabad), (3) black cotton soil of Athwa (Surat), (4) brownish calcareous soil of Padadhari (Saurashtra), (5) blackish calcareous soil of Pratapgadh (Saurashtra) and (6) greyish calcareous soil of Morakhada (Saurashtra). It is found that the sub-soil layers of all the soil profiles contain more total cobalt than the surface layers. The available cobalt per cent of total cobalt varies from 0·5 to 4·8. The available cobalt content of *goradu* soil of Anand decreases with depth from 0·60 ppm. in the surface layer to 0·10 ppm. at a depth of 6 ft. In the top layer of medium black soil of Chharodi it is only one-third of that in the corresponding layer of *goradu* soil, but does not decrease with depth. The top layer of black soil of Surat contains about one-half the amount of available cobalt found in *goradu* soil and decreases with depth. In Padadhari soil of Saurashtra, it is 0·27 ppm. in the top soil but increases with depth, while quite the reverse trend is seen in greyish soil of Morakhada in Saurashtra. In blackish soil of Pratapgadh, the top six inch layer of soil is low in available cobalt (0·15 ppm.), which first decreases to 0·10 ppm. in the next six-inch layer but again increases to 0·35 ppm. at a depth of 2 ft. Out of 6 profiles studied, *goradu* soil of Anand, black soil of Surat, brownish calcareous soil of Padadhari and greyish calcareous soil of Morakhada contain in the surface soil more than 0·25 ppm. available cobalt, a value suggested by Mitchell and Stewart for healthy pastures. But except in Padadhari soil profile, all the others have available cobalt content less than 0·25 ppm. at some depth and more at another depth. Hence whether the amount of available cobalt will be sufficient to maintain pastures which are healthy for animals will depend upon root distribution at different depths.

12. Distribution of copper in typical soil profiles of Gujarat.

V. NEELKANTAN and B. V. MEHTA, Anand.

Copper is one of the links that constitute the chain of inorganic elements that have been conclusively shown to be essential for the healthy and normal growth of plants. Neelkantan and Mehta studied the copper status of 64 surface soils of Gujarat and found that except for a sandy soil in Sabarkantha Dist., all the surface soils are well supplied with available and total copper. Since fruit trees and other crops with a deeper root system obtain their nutrients from the sub-soil also, the present study was initiated and available and total copper distribution in six typical profiles of Gujarat viz. *goradu* soil of Anand (Kaira), medium black soil of Chharodi (Ahmedabad), black soil of Athwa (Surat), brownish soil of Talagana (Saurashtra) and greyish soils of Padhiarka (Saurashtra) and Morakhada (Saurashtra) determined. Maximum accumulation of available copper is found in the top layer of *goradu*, black and medium black soils but this is not the case with calcareous soils of Saurashtra. Only in black soil of Surat, maximum total copper content is found in the top soil, while in the remaining soils it is found at a depth below 2 feet or more. The soils in the present condition contain sufficient amounts of total and available copper.

Factors such as pH, organic matter and finer fractions of the soil, which are reported to affect the total or available copper contents, have been studied. It is found that there is no significant correlation between any of these factors

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and total or available copper contents in *goradu* and calcareous soil profiles. In medium black and black soil profiles there is a significant positive correlation between total and available copper contents, between soil, finer fractions and total copper contents and between finer fractions and available copper contents.

13. Availability of Phosphate in an acidic red loam soil.

A. K. RAI, C. R. PRASAD and S. C. MANDAL, Kanke (Ranchi).

Available phosphate studies were made in an acidic red loam soil at Kanke Farm in Bihar. These studies were conducted in course of an experiment on response of crops to lime and fertilizers. It was generally found that even though lime increased the yields of these crops the available phosphate content of this soil, as determined by the method of Bray and Kurtz, did not increase due to liming. On the other hand there was a definite increase of phosphate concentration in plant leaves in the limed plots, indicating higher uptake of phosphate by plants due to liming. Phosphatic fertilizers applied along with nitrogenous and potassic fertilizers generally increased the available phosphate content of this soil. The increase in phosphate concentration in leaves from the fertilizer treatment was somewhat identical with that obtained from the lime treatment. Lime applied in conjunction with fertilizers pushed the phosphate concentration in leaves still further. These studies suggest that leaf analysis would provide a better index for phosphate availability than soil analysis and it should be resorted to wherever possible. Liming of acid soil distinctly results in higher uptake of phosphates.

14. Clay minerals in Ganges silt.

B. CHATTERJEE, Howrah.

Attempts have been made to determine the nature and relative amounts of clay minerals present in Ganges silt collected at Barrackpore (Palta) during the pre-monsoon and monsoon periods. Studies have been made of the chemical, electrochemical and differential thermal characteristics of the clay fractions isolated from these silts. The chemical and electrochemical data indicate that monsoon silt contains more illite compared to the premonsoon silt sample. D.T.A. data, on the other hand, attribute a more or less similar clay mineralogical make-up of the silt samples collected during the monsoon annd premonsoon periods. Thus, results based on the measurement of any single-valued soil characteristic may often lead to erroneous conclusion.

15. Studies on humification in a tropical red loam soil—I.

C. R. PRASAD and S. C. MANDAL, Kanke (Ranchi).

The uplands of Chotanagpur have acidic red loam soils. These soils are poor in nitrogen, phosphate and organic matter. Even though crop production by the addition of lime and fertilizers has increased the organic matter content of the soils remains almost unaltered in these soils. Addition of organic matter as compost and green manure has also been ineffective in raising the organic matter status of the soil. The degree of humification is very low. With a view to accelerating humification, experiments were conducted during the years 1959-61 with compost and green manure with and without concentrated nitrogenous organic materials. This changed the C/N ratio of the organic matter added to the soil. α-humus was determined as an index of humification on the treated soils every six months. As

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the experiment was laid out in the field, crops were grown every year. α-humus data indicated clearly that by narrowing down the C/N ratio of the organic matter added, the humification was considerably increased. It was, however, observed that during summer there is a drop in the α-humus content while in winter there is a distinct rise. This indicates that α-humus is not quite stable and is subject to seasonal fluctuations. Nevertheless, the interesting fact that emanated out of this study is that whether in summer or in winter the degree of humification is always higher when the organic matter added is of narrower C/N ratio.

16. Soil Moisture correlation with Microflora and Nitrogen transformations in Jute Soil.

A. B. ROY and A. K. MANDAL, Barrackpore.

The influence of seasonal variations profoundly affects the moisture content in the soil and consequently changes the microbial activities. Nitrogen transformations again largely depend on the microbial activities. In the present investigation nitrogen transformations in jute soil and how these vary with the moisture content have been studied.

The fluctuations of moisture content affected the soil microflora. Greater number of fungi was observed in the drier condition of the soil which was much more evident when the soil was incorporated with carbohydrates. The moisture correlation was found to be negative with the fungal growth. But the bacterial count showed a positive significant correlation with the moisture content. The effects of nitrification on varying moisture levels were significant at 5 percent level when not associated with carbohydrates. Nitrification was completely inhibited on addition of energy material in this short incubation study with jute soil.

The increase of Azotobacter, although was not so much marked below 10 percent moisture, the correlation was obtained at all moisture levels. The correlation with Azotobacter and nitrogen fixation was found to be significant at 5 percent level only when energy material was added.

17. Study of the effect of chlorinated insecticides on nitrification on alluvial soil of Gwalior.

HARPAL SINGH and V. S. MEHLA, Gwalior.

It is believed that the increased use of the most important chlorinated pesticides may have some cumulative toxicity of chloride or hydrogen chloride in cases where dehydrochlorination takes place as well as other toxic properties of hydrocarbons and may have harmful effects on soil microorganisms particularly on those which are responsible for converting ammonical nitrogen to nitrate nitrogen and thus retard the formation of available nitrogen which is the governing factor for the yields per acre. To note this effect recommended doses of different pesticides like DDT, BHC, Lindane (Genma BHC), Aldrin, Toxaphane and Chlordane were applied in the 4 lbs. soil and that was incubated at a definite temperature of 36°C keeping 15 per cent moisture level throughout the investigation.

Under the doses applied it is observed that pesticide application does not have any appreciable effect on nitrification. However, pesticides like Lindane, Aldrin and Chlordane had some retarding effect in the beginning which was not observed later. DDT behaved more or less like control with maximum nitrification on 45th day whereas in the case of BHC, Lindane and Toxaphane it reached maximum on 60th day. In case of Aldrin and chlordane it was further delayed and maximum nitrification is observed upto 76th day. Since there is no marked influence of

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these pesticides except of Aldrin and chlordane where there is slow action only in the beginning it reduces the possibility of the concept of the effect of chlorine or HCl on nitrifying bacteria. This is also in support of the previous work of Sen and Singh (1961) where no effect was observed on the total biological population of the soil when studied under different treatments of pesticides.

18. The effect of continuous application of trace elements upon nitrogen fixation in rhizosphere and non-rhizosphere soils of jute crop.

A. B. ROY, H. PAL and M. K. MUKHERJEE, Barrackpore.

The uncropped soils after 5 years of cultivation with jute crop added with different doses of trace elements on acre basis viz. Borax @ 2·5 lbs, Copper sulphate @ 5·0 lbs., Zinc sulphate @ 2·5 lbs. and @ 7·5 lbs., Ammonium Molybdate @ 2·0 lbs. and 5·0 lbs, Cobalt nitrate @ 2·0 lbs, Manganese sulphate @ 2·5 lbs and 7·5 lbs show increased efficiency of nitrogen fixation. The nitrogen fixing efficiency generally increases during the cropping period with or without the application of trace elements. The effeffcts of rhizosphere and non-rhizosphere soils show certain increase in nitrogen fixation nearing 45 days of crop maturity just prior to the application of trace elements.

It has been observed that general depression of nitrogen fixation occurs near about 60 days. But the tendency to show slight increase in nitrogen fixation has been marked at 75 days of crop growth. After 75 days it begins to decline and makes no appreciable difference between rhizosphere and non-rhizosphere nitrogen fixation till the harvesting stage of the crop.

Further addition of trace elements produces no effect in rhizospheric nitrogen fixation. The efficiency falls more or less in rhizosphere than in non-rhizosphere soils.

19. Decomposition of hemicelluloses during fungal retting of *Hibiscus cannabinus* and *H. sabdariffa*.

G. HALDER, A. K. KUNDU and A. K. MANDAL, Barrackpore.

The separation of fibre bundles in the stem of fibre yielding plant is effected by the breaking down of the soft cells surrounding them during retting. It is generally considered that the separation is due to the decomposition of pectic substances present in the walls of such cells. It is, however, found that besides pectin, hemicelluloses are also decomposed during retting of hemp, jute, ramie and Agave sisalana. An investigation was, therefore, undertaken to study whether hemicelluloses are decomposed during retting of *H. cannabinus* and *H. sabdariffa*.

Pectin, Ca-pectate and hemicelluloses isolated from them did not contain any free sugars. Glucose was present in the ribbons of *cannabinus* and glucose and galactose were present in *sabdariffa* in free state. The hydrolysates of hemicelluloses and pectin yielded pentoses and hexoses which were not present in the ribbons in free state except glucose and galactose. Hydrolysates of Ca-pectate yielded only galacturonic acid. The presence of pentoses and hexoses in the pectin hydrolysate is considered due to the admixture of hemicelluloses with pectin. Pentoses and hexoses which were not present in the ribbons in free state were also found in the retting system of *cannabinus* and *sabdariffa* during retting with *A. niger* and penicillium *sp.* Moreover, these sugars were identical with the sugars obtained by the hydrolysis of hemicelluloses isolated from *cannabinus* and *sabdariffa*. This obviously shows that hemicelluloses present in the plant are decomposed into component sugars by fungi during retting.

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20. Reclamation of salt lake in West Bengal.

K. SEN GUPTA, Kalyani.

The salt lake which lies to the east of Calcutta is a vast tract of water-logged swamp covering nearly an area of 30 square miles. This low-lying area was originally formed from the spilled area of the once mighty tidal river Bidyadhari. Gradually the river silted up and the whole area has become a swamp.

Continuous inundation in the past by tidal water from Bidyadhari river and poor drainage due to silting up of the river subsequently have made the soil saline inspite of the fact that rainfall in this area is between 60″ to 75″ per annum. The salinity is of the order of 0·7 per cent and pH varies between 7·2 and 8·4.

Recently, an experiment to reclaim the saline soil was undertaken on a Pilot Polder. The salts were removed from the soil by continuous leaching during the rainy season and the leachate was pumped out. The water table was kept below root zone by pumping. During rabi season irrigation was provided to keep the salt below the root zone.

Crops have been raised both in *kharif* and *rabi* seasons during the years 1958-59, 1959-60 and 1960-61. Yield of Aus paddy and *olitorious* jute in *kharif* season have gone up from 13 mds. 11 srs. and 11 mds. 36 srs. respectively in the year 1958-59 to 18 mds. 20 srs. and 26 mds. 10 srs. respectively in the year 1960-61. Yields of Cabbage and Wheat in *rabi* season have gone up from 144 mds. and 12 mds. 20 srs. respectively in 1958-59 to 204 mds. and 16 mds. respectively.

There is thus a gradual improvement of soil condition which is reflected in the gradual higher yields obtained.

21. Effect of Bentonite additions on the base exchange capacity and water holding capacity of some West Bengal soils.

B. CHATTERJEE, Howrah.

Increase or otherwise in the base exchange capacity and water holding capacity of some West Bengal soils on the addition of increasing doses of a sample of Bentonite (< 20 mesh) has been measured. The base exchange capacities of the soils have been found to increase with increasing addition of Bentonite but the water holding capacities of these soils do not appear to show any appreciable increase on the addition of Bentonite upto 2 per cent under the conditions of the experiment. A decrease in the water holding capacity of the soils has been observed for addition of small doses of Bentonite. Further work on this topic is in progress.

22. Cationic and anionic relationships in different types of tobacco grown in *goradu* soil.

K. A. PATEL and B .V. MEHTA, Anand.

Besides some of the common physiological functions like the buffering of the cell sap, neutralization of organic acids and regulation of salt concentration performed by cations and anions present in a plant, they have some specific functions. Compared with most of the other crop plants, tobacco has a higher ash content (16 to 20 p.c.) and the mineral nutrient needs are also very exacting. In order to get an idea of the variation in the cationic and anionic contents of different varieties of tobacco grown on *goradu* soil, 17 varieties of tobacco were analysed for the important mineral nutrients. It is found that there are differences in the contents of individual cations and anions in different varieties of tobacco grown

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on *goradu* soil, but they are particularly wide in case of calcium, nitrogen, chloride and silicon. The cationic and anionic sums also show a wide variation. But there is a significant positive correlation between the sum of cations and the sum of anions.

23. Soil Survey of Bundi District in Rajasthan State.

V. C. SHARMA and K. M. MEHTA, Udaipur.

Soil survey of 2000 sq. mile area of Bundi district in south-east of Rajasthan state was carried out. Survey of India topo sheet of scale 1″ to a mile were used as base maps. The climate is semi-arid with moderate to severe summer and severe winter. The rainfall is about 28″. The soils of the district fall into two major physiographic regions, the hill region and plain region with scattered out crops and undulating areas. The soils have been divided into thirteen different series. The series has several types and eroded phase and calcareous variant. Morphological, physical and chemical characteristics of five major series in the area have been described. Soil maps have been prepared. This classification will help in planning simple experiments on cultivators' fields with a view to have better and intensive use of varieties, fertiliser and other cropping practices for different soil types.

24. Chemical composition and nutritive value of green Bharra (*Saccharum munj*) grass cut and dried into hay in (i) August and (ii) September.

G. C. LAL, SAXENA, M. M. JAYAL and V. MAHADEVAN, Izatnagar.

The percentage chemical composition of August and September cuts of *bharra* grass hay, on oven dry basis (100°C) is given below :—

Bharra grass :	C.P.	E.E.	C.F.	N.F.E.	Ash.	Calcium (Ca)	Phosphorus (P)	Magnesium (Mg)
1—August cut hay	6·08	1·82	37·15	48·31	6·63	0·35	0·19	0·32
2—Sept. cut hay	4·38	1·34	45·46	42·65	6·17	0·27	0·17	0·26

Feeding trials were conducted on *kumaoni* bullocks, fed as a sole feed. The hays were unpalatable to bullocks. Mixed with wheat bran supplying the digestible crude protein requirements of the animals, limited quantities of chaffed *bharra* hays were consumed comfortably. The remaining dry matter requirements were met by feeding wheat *bhoosa ad libitum*.

The animals consumed an average of 0·61 kg. of the August cut hay and 0·47 kg. of the September cut hay on dry basis per 100 kg. body weight per day, the dry matter ingestion being 1·45 kg. and 1·46 kg. respectively. Thus August cut hay constituted 41·85% of the dry matter consumption of the animals as against 32·19% of the September cut hay.

The average digestibility coefficients for the two hays are given below :

	C.P.	E.E.	C.F.	N.F.E.
August cut hay	40·31	51·73	45·19	30·06
September cut hay	nil	49·16	32·67	25·93

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The percentage digestible crude protein and total digestible nutrients values on dry basis for the two hays are given below :

	D.C.P.	T.D.N.
August cut hay	2·45	35·90
September cut hay	nil	27·39

It may be concluded that August cut hay is superior to September cut hay in nutritive value. In energy value as represented by T.D.N. both the hays are poor.

25. Nutritive value of *Moong (Phaseolus mungo) bhoosa.*

P. S. GUPTA, M. M. JAYAL and V. MAHADEVAN, Izatnagar.

The percentage chemical composition of *moong bhoosa* on oven dry basis (100°C) was : crude protein 11·55, ether extract 1·76, crude fibre 32·15, nitrogen free extract 43·93, calcium 1·76 and phosphorus, 0·18.

Six *hariana* calves fed with *moong bhoosa ad libitum* consumed an average of 2·07 kg. of bhoosa on dry basis, per 100 kg. body weight per day which is indicative of its satisfactory palatability.

The average digestibility coefficients for crude proteins, ether extract crude fibre and nitrogen-free extract were 44·74, 13·48, 42·84 and 45·69 respectively. The percentage digestible crude protein and total digestible nutrients, on dry basis, were 5·17 and 39·55 respectively. All the experimental calves displayed positive retention for nitrogen, calcium and phosphorus.

26. Palatability and Nutritive value of August-cut *bharra (Saccharum munj)* grass hay when fed in combination with green berseem.

G. C. LAL SAXENA, M. M. JAYAL and V. MAHADEVAN, Izatnagar.

Finely chaffed *bharra* hay was thoroughly mixed with finely chaffed green berseem in the ratio of 2 : 5. The mixture was fed *ad lib.* to six *kumaoni* bullocks. The feeding trial extended over 40 days, the last 10 days constituting the collection period. The animals consumed on an average 1·53 kg. of the combined ration, on dry basis, per 100 kg. body weight per day, the contribution from *bharra* hay being 69·28% of total dry matter. When mixed with wheat bran and wheat *bhoosa* the consumption of *bharra* hay on dry matter basis was only 41·55% of the total dry matter. The data show that green berseem is a far superior supplemental feed to wheat bran in enhancing the palatability of the hay.

The average digestibility coefficients for C.P., E.E., C.F. and N.F.E. of *bharra* hay were 40·05, 47·27, 42·23 and 36·31 respectively.

The D.C.P. and T.D.N. values in kg. per 100 kg. of dry matter of the hay were 2·44 and 37·75 respectively.

The experimental animals displayed positive balances for nitrogen, calcium, phosphorus and magnesium and maintained their weights throughout the feeding regime.

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27. Nutritive value of *jowar (Andropogon sorghum)* green, hay and silage.

B. M. PATEL, P. C. SHUKLA and V. V. MISTRY, Anand.

Jowar fodder is fed in green condition. But, if in excess it is stored as hay or silage. Composition and digestibilities of the three forms were studied to evaluate their nutritive values. Results of composition, digestible nutrients and mineral and nitrogen balances have been discussed. Storing as silage showed an increase in ether extract and ash content and decrease in crude fibre content. Silica content was found to be higher in silage and hay than in green form. Digestibility coefficients for green *jowar* were higher for all the constituents except crude fibre. Ether extract and N.F.E. were more digestible in silage than in hay while crude fibre digestibility was higher in hay than in silage. The T.D.N. and D.C.P. supplied by 100 lb. (on dry matter basis) of green *jowar*, hay and silage were 64·5, 4·7; 57·8, 2·5; and 54·9 and 2·3 respectively. Green *jowar* showed positive balance for calcium, phosphorus and nitrogen while hay was in positive balance for phosphorus only and *jowar* silage in positive balance for calcium and nitrogen. Moreover the carotene content in the green, hay and silage forms were found to be 2760, 53, and 850 μ/100^9 D.M. respectively.

Twelve pounds (on dry matter basis) of green *jowar* supply enough nutrients to maintain an animal weighing 800 lbs. while the same amount of either hay or silage would supply enough T.D.N. only and should be supplemented with leguminous fodder to make up the protein requirement.

ANIMAL HUSBANDRY

28. Comparative economics of feeding concentrate mixture and cottonseeds alone to the milch buffaloes.

B. M. PATEL, V. V. MISTRY and P. C. SHUKLA, Anand.

An experiment was conducted on two equal groups of twelve *surti* buffaloes for comparing the cost of feeding concentrate with that of feeding cottonseeds alone taking into consideration the quantity and quality of milk produced. The concentrate mixture consisted of 15% guar meal, 20% each of G. N. cake, cottonseeds, rice polish and maize bran, and 5% *bajri* husks, along with common salt and bone meal at the rate of 2 and 1 per cent respectively.

The results indicated that the cost of feeding concentrate mixture per buffalo per month amounts to Rs. 20/- with production of 258 lb. milk containing 20·3 lb. fat fetching Rs. 58/- whereas in the case of the cottonseed feeding the corresponding values were Rs. 32·70, 275 lb., 21·7 lb. and Rs. 62/-. Thus the net advantage in feeding concentrate mixture as against cottenseed feeding is Rs. 8·70 per month per buffalo, which would mean an annual saving of about 30 million rupees in Kaira District alone. No difference was observed in fat, T.S., S.N.F., CaO and P_2O_5 contents in milk of the two groups.

29. India's cows and plough cattle and their inter-relation with work and milk production.

I. CHATTERJEE, Calcutta.

India has 53·9% male oxen and 27·75% male buffaloes out of 154·68 million cattle and 43·28 million buffaloes (1951 census). The proportion of latter is contrary to the usual tendency in all species for an even sex ratio.

In 15 pre-reorganised states the male oxen vary between 46% and 54%, one has 40·7% and four 55% to 62%. The proportion of buffalo male varies from 5·73%

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in Delhi to 37% in Bihar. Only in Assam, M.P., Orissa, Trav. Cochin and West Bengal it is between 47% and 69%. In other age groups also the variation amongst buffalo males is erratic but much less seen among oxen.

In ten out of 21 states viz., Assam, Bihar, M.P., Orissa, West Bengal, Jammu and Kashmir, Rajasthan, Trav. Cochin, Himachal Pradesh and "Other areas" more cow milk than buffalo milk is produced. In Madhya Bharat and Mysore both milk are evenly divided. In the remaining 9 States more buffalo milk than cow milk is produced.

In seven states the working male oxen constitute less than 1 per cow, in two about 1, in seven 1·05 to 1·2, in another three ,1·33 to 1·38, in Bombay 1·51, in U.P. 1·87 and in India 1·23. The proportion is such that even a lesser number of cow can produce the same or even more number of males. If so, our belief that cows are mainly maintained for their males and so their milk yield is low needs modification.

The real cause of low milk yield is related as much with large number of cows as with the high proportion of dry ones. In 15 out of 21 states the dry cows preponderate, and are 3·14 times of wet ones in Hyderabad, 2·3 times in Orissa and Mysore, 2 times to 1·73 times in Madhya Bharat, Madras, Bihar, Trav. Cochin, Vindhya Pradesh and Jammu and Kashmir. In India it is 1·5 times. Only in Punjab, Delhi, Saurastra and PEPSU amongst better situated states and Assam (low yield area) there are more wet than dry cows. Such a situation seriously hampers economic milk production, and can hardly be congenial even for production of efficient bullocks.

If a phased elimination of dry cows at the rate of 7% to 15% in three states, 18 to 39% in ten states and 52% in Hyderabad be carried out it will bring 20% reduction in India with corresponding reduction in maintenance cost and producing cost of milk. This is possible without slaughter.

30. Studies on carotene content in some fodders and tree leaves.

B. M. PATEL, P. C. SHUKLA and V. V. MISTRY, Anand.

Carotene content in various fresh and stored fodders and tree leaves at different stages of growth has been reported. The results indicated that due to storage of about 2—3 months, there was a loss of about 90 per cent carotene content in fodders, while it was somewhat low in tree leaves. It was also observed that *bajri* and *jowar* fodders containing about 350 and 120 rg. carotene per gram of dry matter respectively lost practically all their carotene content at 12 weeks' growth while maize which was low initially lost its carotene content earlier at about 10 weeks' growth.

Among tree leaves, *samadi* (*Prosopis spicigera*) and tamarind contained about 235 rg. and *neem* (*Melia azadirachta*) and *rayan* (*Mimusops hevandra*) contained only about 170 rg. carotene per gram of dry matter. However, castor contained very high amount (369 rg./g.). It was observed that these tree leaves are slightly richer in carotene content during winter. It is estimated that feeding of only about 4 lb. of fresh tree leaves/day would fulfil daily carotene requirement of a farm animal.

CROP PHYSIOLOGY

31. Further modifications of the technique for determination of chlorophyll stability index (C.S.I.) in relation to studies of drought resistance in rice.

S. K. MAJUMDER and K. S. MURTY, Cuttack.

Chlorophyll stability index (C.S.I.) of plants was earlier reported to be correlated with drought resistance. The technique for estimating C.S.I. is further

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modified in view of these considerations : (a) chlorophyll stability of varieties can be more effectively tested at higher temperatures, amplifying varietal differences in C.S.I. values; (b) economic use of acetone and reduction in the duration of heat treatment were considered important in view of a large number of varieties under examination.

One gram of fresh leaf, soaked in 25 cc. of water and heated in a water-bath maintained at 65°±1°C. for 1 hour, is extracted with 40 cc. of 80% acetone in a Waring blender for 5 mins. The extract is filtered through no. 1 filter paper and Colorimetric (Klett Photo-electric) reading of the filtrate is taken using no. 66 red filter. Similar reading from an unheated sample is taken as control. The difference between these two readings is designated as C.S.I. of the variety concerned.

Preliminary results indicate that C.S.I. values for known "drought resistant" varieties are consistently lower than those of typically wet-land varieties. Work is now in progress to establish the relationship between the C.S.I. of a particular variety and its final performance in terms of yield under periodic drought conditions.

32. Inducing drought resistance in rice.

B. N. SAHU, Bhubaneswar.

Small amounts of organic extracts appear to stimulate growth to a marked degree. Such substances bring about certain changes in the metabolic process of the plant and thereby increase the drought resistance of the plants. Vitamins and growth hormones like Riboflavin and Nicotinic acids have been attributed to possess certain properteis. *Convolvulus pescaprae* (*Ipomoea bilobata Forsk, Kansari nai*) is a creeper that grows along the sea face from Balasore southwards and in the sandy beds of the rivers in Orissa. This creeper possesses drought resistance qualities. The creeper must have certain principles either in its roots, stem or leaves in a free moving or in bound form which contribute to its drought resistance capacity.

It was therefore considered to make use of this principle of the creeper in inducing drought resistance in rice crop during its growth.

An experiment was laid out in Agronomy Section of the State Agricultural Research Station, Bhubaneswar, Orissa to study the effect of the Riboflavin and Nicotinic acid along with the different parts of *Convolvulus pescaprae* L. in inducing drought resistance in rice. The experiment was laid out in a split plot design. The interval of irrigation was (1) every day; (2) seventh day and (3) tenth day in the main plot and in the treatments with :—

A. Nicotinic Acid 100 p.p.m.
B. Riboflavin 100 p.p.m.
C. Water suspension of root paste.
D. Water suspension of stem paste.
E. Water suspension of leaf paste of *Convolvulus pescaprea* L.

The strength of Nicotinic Acid and Riboflavin was 100 p.p.m. Pastes of the roots, stems and leaves of *Convolvulus pescaprae* ere suspended in water.

Paddy seeds of N. 136 were soaked in each of the solutions for 24 hours and then were kept under vacuum pressure for one hour. Thereafter the seeds were sown in the seedbed and transplanted in experimental plot when the seedlings were four weeks old.

The experiment was concluded during the summer season as Dalua crop and was replicated twice. Ingredients of *Convolvulus pescaprea* plant were sprayed after 45 days, 60 days and 75 days of the rice plants.

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The results of 1958-59 and 1959-60 indicate that Nicotinic Acid induces greater drought resistance capacity than any other treatment. The next to it is water suspension of root pastes of *Convolvulus pescaprea* L (*Ipomoea bilobata*).

33. Effect of different synthetic hormones on growth and development of Jute.

B. K. KAR and J. R. SAHA, Barrackpore.

Corchorus capsularis var. JRC 212 was grown in replicated microplots (5×7 ft.) in lines. When the plants were one month old, they were sprayed with Indolyl acetic acid (IAA); Indolyl butyric acid (IBA); Indolyl propionic acid (IPA) and Napthalene acetic acid (NAA) in concentrations of 500 ppm and 1,000 ppm. Spraying was done twice at an interval of ten days.

The treated plants showed prominent curvature of the growing shoot apex which gradually recovered, leaving traces of curvature and in the region of curvature, the radial growth of the stem was appreciably increased. 500 ppm was more effective than 1,000 ppm. The after effects manifested themselves in increased growth rates in height and basal diameter of the stem, in leaf surface, in total green and dry weights.

The percentage increase in fibre yield varied from 7·0% to 41·0% per plant according to the different hormones used. In IPA and NAA treatments, the increase was more than in IAA and IBA.

Stimulation of cambium activity, affecting the formation of xylem and phloem was recorded by estimations of fibre-wedges, fibre-strands per wedge and ultimate fibre cells per strand, which constitute the fibre-complex and determine the yield of fibre.

34. Effect of Foliar Spray of Gibberellic Acid on the Growth of Tomato Plant *(Lycopersicum esculentum L.)*

B. PARIJA and K. C. MAHAPATRA, Bhubaneswar.

The effects of different concentrations of gibberellic acid on the growth of the plants of two tomato varieties were studied. From the observations of growth characters such as height of the plants, number and length of leaves and internodes etc., it is evident that the local variety responded better in the treatment with 50 p.p.m. of the acid whereas the response was greater with a higher concentration (100 p.p.m.) in the American variety—'Oxheart'. The two varieties behave differently in the initiation of flower buds with different concentrations of gibberellic acid. The application of 50 p.p.m. and 100 p.p.m. induced earliness in flowering in the local and the American varieties respectively. The differential growth responses in two cases under the same conditions may be attributed to the difference of the varietal nature of the materials. In both the cases the treated plants exhibited better performance in growth behaviours than the controls. Further work on the ascorbic acid content, carbohydrate fractions and seedlessness is in progress.

35. Effect of Spraying Glucose and Ascorbic Acid on the Survival of Albino Seedlings of *Oryza sativa, L.*

P. C. PARICHA and SITARAM MISRA, Bhubaneswar.

The present investigation was carried out to find out the factors for the viability of homozygous mutants deficient in chlorophyll as also the physiology of gene

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action. The albino mutants of *Oryza sativa*, L. var. PTB—10 were obtained by irradiating to gamma rays of 20,000 r. The albino mutants were isolated from the other chlorophyll mutants by following the classification of Gustafsson (1940).

In order to prolong the life of the plants the leaves were sprayed with a solution of glucose of 200 p.p.m. alone and in combination with 25 p.p.m. of ascorbic acid.

Spraying with glucose alone did not prove as useful in prolonging the period of survival and increasing the height of the plants as in sprays combined with ascorbic acid, though the former was superior to the control. The plant height and longevity were twice as much in glucose plus ascorbic acid spray when compared against their counterparts in the control. Tiller formation was also observed in the treatment of glucose and ascorbic acid spray which was absent in the other treatments.

From the results so far obtained, in the present experiment, it would not be completely inappropriate to say that glucose as well as ascorbic acid are the two factors, though not the only factors, limiting the growth of the albino plants. The albino plants can suitably be exploited, through detailed studies, to know more about the limiting factors in order to explain the physiology of gene action.

36. Studies on embryo culture of rice.

PRADYOT K. BHANJA, Calcutta.

In recent years, culturing of excised embryos of Japonica rice is being practised in Japan. With a view to standardize the technique for culturing of excised mature embryos of Indian varieties of rice under local conditions, experiments were performed, the results of which are as follows :—

1. Complete excision without injuring the embryo is possible after pre-soaking the seeds in water for 4 to 6 hours.

2. Best growth of the embryos can be obtained only when the medium has a pH between 5·5 and 6·0.

3. The presence of boron as a trace element in the medium is essential for healthy growth of the embryos.

4. Copper and molybdenum are toxic to the excised rice embryos when they are present in the culture medium even in very minute traces.

5. The presence of indoleacetic acid at low concentrations in the culture medium is essential for timely root initiation and the development of a proportionate root system.

6. Yeast extract is a good composite source of vitamins and produces a more balanced growth of the seedlings than the synthetic vitamins do.

7. Autoclaved coconut milk does not significantly promote or inhibit the growth of excised rice embryos.

8. Gibberellic acid, when present in the medium, remarkably stimulates elongation of the internode cells of the seedlings at a particular age.

9. In the seedlings of rice, reared from embryo culture, certain deleterious symptoms appear after transplantation and unlike those of rye or barley, they fail to establish themselves into adult plants when grown in such comparatively simpler medium like that of Gregory and Purvis. But these symptoms can be overcome by using modified White's medium containing IAA and yeast extract.

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37. Studies on the growth of isolated tissues of rice 1. Effect of iron and Gibberellic acid on light inactivated growth process.

T. M. DAS and A. SHOME, Calcutta.

From 72 hours germinated seedlings of rice var. *Chinsurah Boro* 1, 8 mm. root-tip and 5 mm. coleoptile segments were cut off and inoculated in a 100 ml. beaker containing 50 ml. of modified Burstrom nutrient solution (1960). The experiment was carried out under controlled light and and temperature conditions.

It was observed that elongation of root cells was always accelerated in the dark with iron, but in the absence of iron growth was significantly greater in light. The optimum requirement of $FeCl_3$ for growth of root-tip and coleoptile segment is the same (10^{-5}M). In decapitated coleoptile segments a lower concentration of $FeCl_3$ ($10^{-6.5}$M) was found favourable for growth.

Root growth was stimulated with GA (0·01 mg/L) but at higher concentrations, GA slightly inhibits the root growth. With lower concentration the maximum rate of growth was attained during the early period of the experiment, but this was reversed at higher concentration. GA reverses the iron-induced inhibition in light. Higher concentration of GA (0·1 mg/L) has been found to accelerate growth of intact and detipped coleoptile. In the roots by the dual action of GA and iron the growth was lessened than by GA alone. However, in the coleoptile segment neither decreased nor increased growth was noticed.

38. Seasonal variations in dormancy and viability of paddy seeds.

B. N. GHOSH, Chinsurah.

Three varieties of aus (summer) : Kele, Jhanji—34 and Satika, three varieties of aman (winter) : Latisail, Badkalamkati—65 and Rupsail and four varieties of boro (spring) : Chinsurah boro—I, Chinsurah boro—2, Tepa—I and Tepa—II, were studied both in the boro (dry) and kharif (wet) seasons to determine seasonal variations in dormancy and viability. The seeds were germinated on moist blotting paper in petri-dishes at room temperature, five petri-dishes being used as replications for each variety. The first counting of germination was recorded fifteen days after harvest and then monthly records noted up to one year.

The germination percentage in aus, aman and boro is found higher (more than 90) in the boro season than in kharif, indicating no dormancy in these varieties when collected during the boro season. In boro varieties, however, the seed when collected in kharif shows no dormant period, the germination percentage being more than 90; but in aus and aman, there is dormancy of varying degrees. In aus varieties there is slight dormancy, the percentage germination fifteen days after harvest in Kele, Jhanji—34 and Satika is 64·1, 59·3 and 59·1, respectively; whereas in aman varieties, there is a definite dormant period in Latisail and Rupsail as there is no germination of seeds fifteen and forty-five days after harvest at room temperature. But when the seeds of these two varieties are germinated at a higher temperature in a wide-mouthed Thermos flask washed with boiling water, the germination percentage fifteen and forty-five days after harvest is 32·2 and 66·2 in Latisail, and 27·8 and 67·8 in Rupsail, respectively. In Badkalamkati—65 slight dormant period is noticed as the germination percentage is 60·8, fifteen days after harvest.

As regards viability, the seed of aus variety loses viability within a year when collected during the boro season, but no such loss is recorded in the seed collected during kharif. The viability of the seed of aman and boro varieties when collected in the boro and kharif seasons remains intact throughout the year except in the

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two boro varieties, Tepa—I and Tepa—II, where deterioration in germination of the seeds collected during the boro season is noticeable 255 days after harvest.

From the result of the above study, it seems that the seasonal effect on dormancy and viability of paddy seeds is of varietal nature, since the seeds of different varieties behave differently. Further studies are in progress.

39. Analysis of the effect of very short exposure to light on growth of mosocotyl and coleoptile of rice.

T. M. DAS and J. M. CHOUDHURI, Calcutta.

In this experiment seedlings of rice var. *Rupsail* were cultured for 120 hours when they were periodically exposed to light, durations of which were—(1) 1/2 second, (2) 2 seconds, (3) 15 seconds, (4) 30 seconds, (5) 45 seconds, and (6) 1 minute at every 24 hours of darkness. Control sets of continuous darkness and continuous light were also maintained. The intensity of light of the experiment was 125 f.c. and temperature was 30·3°C.

From the result of the experiment it is quite apparent that the most sensitive part of the embryo to light was the mesocotyl. The 100% inhibition of growth of mesocotyl by light was recorded at the minimum periodic exposure of one minute. The exposure to light as brief as 1/2 second also possessed inhibitory action on the growth of mesocotyl. Growth of the coleoptile was significantly inhibited by light at the minimum periodic exposure of 15 seconds. In the case of second leaf, third leaf and root no significant differences were obtained between different treatments with short exposure to light.

40. Studies in Photoperiodism. I. Effect of photoperiods on growth and reproduction of a few perennial species of plants.

J. K. CHOUDHURY, Allahabad.

Photoperiodic behaviour of perennial plants are known to a lesser extent compared to that of crop plants and other annuals. This information in respect of the former group may, however, be of great help in breeding, shortening of juvenile periods, plant introduction etc. with consequent advantage to horticulture, forestry and silviculture. To gather such information and also to evolve a working technique, a few shrubby and tree species are being raised in different day lengths and a preliminary account of this work is incorporated hereunder in respect of those which have already shown some results.

The species reported here are *Ricinus communis* Linn., *Datura innoxia* Mill. and *Lochnera rosea* (L) Reichb. They were raised in big pots and kept in Long (16 hours), Short (6 hours) and Normal days (about 12 hours) when they, respectively, were 25, 41 and 40 days old from germination. All the plants were kept in the open during the day, but at specified hours short and long day plants were removed to two separate rooms to continue with their respective treatments.

Results show that long days encouraged vegetation growth and also earliness in flowering by 18, 21 and 9 days in *D. innoxia, R. communis* and *L. rosea* after a treatment period, respectively, of 26, 48 and 49 days during January to March, 1961. Flower buds in short day plants appeared 8 days after and 2 days before those in normal day ones in *L. rosea* and *D. innoxia*. Short day *R. communis* has not flowered so far. Relationship between day lengths and height, basal diameter, number of internodes and of leaves, internodal length etc. of the plants were noted. The work is still in progress.

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41. Experiment on paddy in relation to musical sound.

G. PURUSHOTHAMAN, Pondicherry.

Consequent on the researches of Professor T. C. N. Singh on paddy at Sirkali (Madras State), four experiments were laid out in four different villages in the Pondicherry state, on paddy in relation to musical sounds. The control and experimental crops were raised and maintained under identical conditions. Excitation to the crops was dosed by playing recorded music of *"Charukesi"* raga piped on *Nadeswaram* relayed and amplified through a loud-speaker which was placed on the bund of the experimental plots. The crops were stimulated for half-an-hour every day till the crops attained maturity. Periodical observations were made and data were gathered at all stages of the crop growth. The results were subjected to statistical scrutiny.

As a result of the musical stimulus, the "Listening" crops had grown taller and bigger with better developed root system than the control crops, not subjected to stimulation. The former produced longer panicles with greater number of grains in them than the latter. The effect on the reproductive phase of the plant due to the stimulation was noteworthy and remarkable and the grain as well as the straw yields were significantly increased ranging from 22% to 58% and 30% to 62% respectively.

Village Centres.	Yield of grain in lb.		% of increase.
	Control.	Experiment.	
Arasur	2543—12	3737—8	46·9
Sembipalayam	2648—12	3245—0	22·1
Abishegapakkam	2586—00	3855—$\bar{0}$	49·$\bar{0}$
Porayur	2450—00	3875—0	58·1

CYTOGENETICS AND PLANT BREEDING

42. Observations on natural crossing by insects in Olitorius Jute.

N. DUTT and S. K. GHOSE, Barrackpore.

Present study was undertaken to ascertain the actual agent or agents involved in cross-pollination in olitorius jute and measure the percentages of natural crossing as affected by different agents. For the purpose, JRO—632, a full green type and JRO—620, a light red type were sown in alternate lines, 1′ apart, in a plot of 30′ × 30′, during 1960-61 season. There were altogether 30 lines in the plot, 15 of each type. 30 plants of full green type (JRO—632), 2 from each line, were selected. Of these 30 selections, 15 were screened, one from each line, before the start of flowering, by cages (2′ × 1′ diam.) made of 16-mesh wire-netting. Lower end of each cage was connected with a cloth cylinder of 1′ in length for tying with the plants. 15 other selections were kept open and were unscreened. Progenies from each of these selected plants, screened or open, were raised podwise, separately, in the following season, namely, 1961-62 and observations were made on F_1 population on the basis of pigmentation *i.e.* full green or light red type. None of the progenies of the screened JRO—632 contained any pigmented plants and they were all full green type like the recessive mother. Natural crossing in these was nil. It is, therefore, suspected that wind does not play any role as an agent for cross

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pollination in jute as the meshes of the wire-net cages were sufficiently big to allow entry of pollen grains.

In the unscreened plants, natural cross was 5·26% on average, the range being 2·90% to 14·35%, during 1960-61. Flowers were visited freely by various insect species and crosses were effected. Because wind plays a negative role as an agent of cross-pollination in jute, natural cross percentage as obtained in unscreened plants, therefore, gives the estimate of cross-pollination by insects.

43. Rate of pollen tube growth in *Corchorus aestuans* Linn. (= *C. acutangulus* Lamk), *C. siliquosus* Linn. and *C. sidoides* F. muell, wild jute species.

R. M. DATTA and B. S. PANDA, Calcutta.

In all these three jute species maximum growth takes place in the first hour. Different sugars are suitable for different species in different concentrations.

Pollen tubes do not grow beyond 3 hours in *C. sidoides*, whereas they grow for 4—4½ hours in *C. aestuans* and *C. siliquosus*, a natural polyploid.

Detailed discussion is given in the paper with curves etc.

44. Pollen grain morphology of *Corchorus asplenifolius* Burch., a wild jute of Africa.

R. M. DATTA and B. S. PANDA, Calcutta.

Pollen grains are oblate tricolpate. Tetracolpate grains have been found. The OL—pattern was also observed, similar to that found in other species of *Corchorus*. Exine is reticulately thickened; the thickenings appear as radial bars in sectional view. Three germ pores are found usually, one each in the middle of a fusiform germinal furrow. Intine does not protrude through the germ pore in ungerminated pollen.

45. Effects of Maleic hydrazide and 2,4-Dichlorophenoxyacetic acid on the pollen tube growth of *Corchorus siliquosus* Linn., a wild jute of America.

R. M. DATTA and B. S. PANDA, Calcutta.

Pollens were cultured in sucrose and lactose media with different concentrations of MH and 2, 4-D.

The growth of pollen tubes is more in all the concentrations of MH used, whereas it is almost always less in different concentrations of 2, 4-D except in case of 7 p.p.m. concentration.

When compared between sucrose and lactose with MH, it is clear that there is very much increase in the former.

Different bar diagrams illustrate the effects on growth of pollen tube.

46. Karyotypes of 4n *Corchorus olitorius* L., strain C. G., 2n × 4n population of *Corchorus olitorius* L., strain C. G., 4n *Corchorus capsularis* L., strain D154 and *C. fascicularis* Lamk., cultivated jute species and its wild ally.

R. M. DATTA and B. S. PANDA, Calcutta.

Roots, measuring 5—6 mm. in length, were pretreated in fresh Aesculin solution and were kept for not less than 3 hours at a temperature of 8—9°C. After

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pretreatment they were fixed in Acetic-alcohol (1 :2) for 45 minutes to an hour. Then they were squashed in aceto-orcein after hydrolysis.

Chromosome morphological studies reveal differences between different species of *Corchorus*. 4n *C. olitorius* (an autotetraploid) has its karyotype—A_2 B_4 C_4 D_3 E_1, 4n *C. capsularis* (an autotetraploid)—A B_3 C_2 D_6 and diploid *C. fascicularis* has A_2 BC D_3.

2n × 4n (3n) *C. olitorius* (an autotriploid) shows variations in chromosome numbers in its tissues, ranging from 12—56, maximum frequency being 28 in the cells studied so far.

Karyotype of *C. fascicularis* is reported for the first time. Those of 4n materials show variations, when compared to the respective 2n materials. (cf. Sharma and Roy, 1958).

Along with polyploidy, reduction in size of the chromosomes is noted.

47. Effect of auxins and antiauxins on the rate of pollen tube growth of *Crotalaria juncea* Linn.

R. M. DATTA and P. K. BISWAS, Calcutta.

The average stylar length of *Crotalaria juncea* Linn is about 16000 microns which means that the tube length obtained *in vitro* with or without the three chemicals used (3—Indole acetic acid, Napthoxy acetic acid and Maleic hydrazide) falls much short of the minimum that would be acutely required to affect fertilization.

From data available it is evident that at least these three chemicals—two auxins and the other antiauxin—individually are not suitable for pollen tube elongation for the purpose of hybridization work.

48. Somatic chromosome numbers and Karyotypes in some species of the genus *Crotalaria*.

R. M. DATTA and P. K. BISWAS, Calcutta.

Five types of chromosome pairs were noted in both the species, but the number of pair or pairs of chromosomes included in each type varied in the two species.

Length of the chromosomes in *C. verrucosa* was relativtly longer than that of *C. saltiana* (=*C. striata*).

Both the species have only one pair of secondary constricted chromosomes.

In *C. striata* out of the 9 constrictions 4 are median, 4 are submedian and one subterminal in position, whereas in *C. verrucosa* 3 are medium, 4 submedium and 2 subterminal in position.

Somatic chromosome number 2n=16 for *C. ferrugiana* is reported for the first time.

49. Meiotic studies and chiasma frequencies in some *Crotalaria* species.

R. M. DATTA and P. K. BISWAS, Calcutta.

Meiotic studies show some irregularities. Hypo- and hyperploid cells occur as in other species of *Crotalaria* (Datta, 1933; Atchison, 1955 and Roy and Sinha, 1958). Unreduced gametes found in *Crotalaria usaramoensis*, though rare, is a new record. These irregularities reflect on the pollen fertility percentage.

A comparative study of chiasma frequency in these three species shows that

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there combination of characters is maximum in the wild species (*C. usaramoensis*), (1·3 average chiasma per bivalent) and between the other two species, namely *C. juncea* (cultivated) and *C. verrucosa* (wild), the former shows more recombination of characters (1·25 as compared to 1·23 of the latter).

HORTICULTURE

50. Effect of hybridization in mango on physio-chemical characteristics of fruits.

P. C. MALLIK, T. S. N. SINGH and S. PANDEY, Sabour.

Crosses were made in mango in 1942-44 for combining economic characters which might lead to the commercial possibilities of the hybrids. About two dozen seedling plants are still growing and many of them have fruited. The description of the fruits and their respective qualities have been presented.

In hybrid Langra × Sunder Prasad, the fruits are identical to Langra with flavour and colour of the skin much improved. The yellow-red flesh of Sunder Prasad has come to the hybrids. This fruit will score over the present Langra in their market quality.

In the cross between Bombay and Kalapady, the hybrid has got bigger sized fruit with predominant Bombay taste, but ripening one month later. The fruits have also got good keeping quality like Kalapady.

Total sugar and acid remain intermediate but Vitamin C has in some cases increased enormously, but still remains lower than the rich parent. Only in Amandesheri × Barmasia cross, the Vitamin C has increased very much than both of the parents.

Other characters are intermediate in some, and in others, some characters of one parent predominate.

51. Effect of a fungicidal wax coating with or without growth regulators on the storage behaviour of mangoes.

H. SUBRAMANYAM, N. V. N. MOORTHY, V. B. DALAL and H. C. SRIVASTAVA, Mysore.

Fully mature green mangoes (Alphonso variety) were dipped in aqueous wax emulsion containing 6 per cent solids and one per cent sodium-ortho-phenyl phenate with or without growth regulator like maleic hydrazide (MH) or 2, 4-dichlorophenoxy acetic acid (2, 4—D). After treatment fruits were dried in a current of hot air (Ca 120°F) and stored at 79°—86°F and R. H. 55—87%. Periodical observations were made regarding physiological losses in weight; ripening behaviour and changes in moisture contents, acidity, TSS and ascorbic acid. Percentage wastage was also recorded and all observations were compared with the controls. It was found that there was considerable delay in ripening in the treated fruits as compared to the control. After twelve days, it was noted that there were higher percentage of green fruits in lots treated with wax emulsion containing 250 p.p.m. MH or 20 p.p.m. 2, 4—D., as compared with waxed or control. However, there was no significant difference between the two treatments containing different growth regulators. The unwaxed fruits ripened within six days as against twelve days for treated fruits. The fungicide used in the above wax emulsion delayed the development of incipient infection, but failed to control decay (due to latent infection) in fruits during ripening.

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52. Inhibiting the growth of microbial activities in unprocessed canned fruits by phenomenon of antibiosis and to study its effects on the organoleptic quality of fruits—Part II mango.

P. C. MALLIK, U. P. VERMA, S. PANDEY and S. AHMAD, Sabour.

The use of antibiotic agents namely Terramycin, Aureomycin and Achromycin, in canning of mangoes have proved quite effective in checking completely the growth of any spoilage organisms inside the cans, even though they were not subjected to the processing operations. The cans remained quite fit and its contents edible at the end of one year's storage period. The fruit slices remained firm in texture and original in colour and taste in all non-processed antibiotic treated cans. The vitamin C content had minimum loss in cans treated with 100 ppm Terramycin. Terramycin has been found to be superior to other antibiotics used, with regard to taste, quality and appearance of the fruit slices. The actual quantity of Terramycin present in each can comes to 17·85 mgms in 100 ppm treated cans which is far less an amount when compared to usual therapeutic dose that being two capsules of 250 mgms each per day for a patient.

The cost involved in the use of antibiotics per can is 11 np whereas in cans subjected to usual processing operations followed in Canneries comes to about 20 np per 1 lb. Jam size cans.

Owing to the fact that these antibiotic substances are usually bitter in taste, the maximum dose has to be kept at the lowest level of its effectiveness so that the bitterness added is not perceptible. The 100 ppm has been found to be a safe dose. Further work in order to examine its economic aspects on commercial scales will have to be done.

53. Role of pre-cooling on the storage behaviour of sweet oranges (*Citrus sinensis* Linn., Osbeck).

N. V. N. MOORTHY, N. S. KAPUR and H. C. SRIVASTAVA, Mysore.

Sweet oranges (*Citrus sinensis* (Linn.) Osbeck washed in a solution containing 0·2% sodium orthophenyl phenate, dried in a current of cold air, were pre-cooled at 32-35°F for 16 hours till the temperature at the centre of the fruit reached that of the surroundings. They were then stored at room temperature (75-92°F., R.H. 45-70%) and at 68-70°F and R.H. 75-80%. It has been found that there was a better retention of moisture, ascorbic acid and acidity in the pre-cooled fruits. The physiological losses in weight and wastage were less in the case of treated fruits. The juice recovery of the treated fruits were much higher after 19 days of storage as compared to the controls.

54. Effect of skin coating on storage behaviour of Sathgudi oranges (*Citrus* Simensis Linn., Osbeck).

V. B. DALAL, V. C. MAMADAPUR, N. S. KAPUR and H. C. SRIVASTAVA, Mysore.

Skin coating with aqueous fungicidal wax emulsion extends the storage life of sathgudi oranges and reduces spoilage during refrigerated and common storage. The fruits treated with 6% fungicidal wax emulsion were stored at room temperature (75-92°F) and optimum temperature (42-45°F). Respiration rate, physiological loss in weight, spoilage, total soluble solids, acidity, moisture content, oil content of peel, juice percentage and general acceptability were determined periodically. It is evident from the data that skin coating reduced the physiological loss in

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weight and rate of respiration considerably thereby imparted the fruit with physiological vitality and an attractive gloss. The spoilage also was very low among the treated fruits. The waxed fruits were fresh even after 3 months storage at low temperature and 4 weeks of storage at room temperature as against 2 months and 10 days respectively of untreated fruits.

55. Studies on the effect of repeated wax coating on the storage behaviour of Coorg oranges (*Citrus reticulata, Blanco*)

V. B. DALAL, H. SUBRAMANYAM and H. C. SRIVASTAVA, Mysore.

Freshly harvested, mature, healthy Coorg oranges were subjected to fungicidal wax coatings by dipping them once, twice, thrice and four times with or without alternate drying, in an aqueous fungicidal wax emulsion containing 4% solids and 1% sodium ortho phenylphenate. Treated and untreated fruits were stored at room temperature (79-86°F; R.H. 55-87%) and their storage behaviour was studied with reference to physiological losses in weight, percentage wastage due to diseases, shrivelling burns due to fungicide, changes in Vitamin C content, titratable acidity, total soluble solids, juice content and respiration rates. Among untreated fruits, shrivelling was very high and therefore they were unmarketable during storage. However, fruits treated more than twice with aqueous fungicidal wax emulsion resulted in damage to the peel of the fruits and poor marketability. Fruits, waxed twice by alternate dipping and drying showed no wastage, minimum shrivelling and gave large number of marketable fruits with excellent gloss and firm texture at the end of 24 days of storage at room temperature. Vitamin C content, juice percentage and titratable acidity declined gradually and total soluble solids increased gradually in waxed fruits. These studies revealed the limitations associated with repeated coatings on Coorg oranges stored at room temperature.

56. Storage behaviour of various products obtained from the skin coated oranges.

N. S. KAPUR, V. C. MAMADAPUR and H. C. SRIVASTAVA, Mysore.

The storage behaviour of the juice, squash and marmalade prepared from treated and untreated sweet oranges stored at low temperature (42-45°F, R.H. 85-90%) and room temperature (75-92°F, R.H. 45-70%) was studied. Sweet oranges were treated with 6% fungicidal wax emulsion containing 0·5% SOPP as a fungicide. The products made out of such variously treated and stored oranges were stored at three temperatures viz., airlock (68-70°F), room temperature (75-92°F), and 98·5°F (37°C) for a detailed study. Products made out of the fresh fruits were compared with those made from treated and untreated fruits stored for different periods at room and low temperature. Brix, acidity, changes in pH, ascorbic acid, optical density at 420 mμ, sugars and colour measurement (Lovibond Tintometer) as well as organoleptic evaluation, were made periodically for squash, juice and marmalade. As a typical case the products from 2 months cold stored, treated and untreated oranges were compared with products from fresh fruits. It was found that the processing of oranges stored under refrigeration for 2 months does not adversely affect the quality of the products. The retention of ascorbic acid was greater in the products made out of the treated fruits.

Similarly products made out of treated oranges cold stored for 3 months and stored for 4 weeks at room temperature compared well with those made from fresh fruits. Thus the processing time for factory could be considerably extended.

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57. Role of skin coating on processing of sweet oranges (*Citrus sinensis* Linn., Osbeck).

V. C. MAMADAPUR, N. S. KAPUR and H. C. SRIVASTAVA, Mysore.

Various products like juice, squash and marmalade were prepared from the treated and untreated oranges, stored at room temperature and at optimum low temperature. Brix, ascorbic acid, sugar acid ratio, pH, colour changes and organoleptic evaluations were made for all the products at regular intervals during storage and compared with products from fresh fruits. It was found that treated fruits kept for 4 weeks at room temperature and for 3 months in cold storage, could be processed satisfactorily, whereas the unwaxed fruits stored for more than 3 weeks at room temperature and more than 2 months at low temperature yielded products of poor quality. Further, the spoilage in unwaxed fruits exceeded 10% level after 10 days at room temperature and 2 months at low temperature. Thus the untreated fruits could only be processed economically for 10 days and 2 months against 4 weeks and 3 months in the case of treated fruits stored at room temperature and low temperature respectively.

58. Studies on the effects of manurial treatment with N, K, Ca in combination on canning qualities of Litchi fruits.

P. C. MALLIK, U. P. VERMA, S. PANDEY and S. AHMAD, Sabour.

The effects of N, K, Ca on the canning qualities of fruits applied in combinations, to litchi plants in a separately conducted manurial trial in Horticultural Garden, Sabour, have been studied. There were twelve treatments having three levels of N, two of calcium and one of potash. N in the form of $(NH_4)_2SO_4$, Ca as lime and K as K_2SO_4 were applied. It is found that potash plays a more important role in making the fruits less susceptible to browning during storage, specially in combination with increasing dose of calcium and nitrogen. In absence of potash, nitrogen with calcium appears to have little effect in checking browning of fruits during storage. Increased nitrogen has been found to affect vacuum in the can during storage, and compared to other treatments, the fruits obtained from plants treated with high nitrogen dose reduced the vacuum in the can considerably.

59. Possibility of increasing the life-span of the coconut palm.

T. A. DAVIS, Calcutta.

Unlike the monocarpic palms that complete their life with the first flowering, the coconut palm (*Cocos nucifera*) is capable of growing indefinitely since the origin of its spadices is axillary. However, the latter seldom lives beyond its hundredth year as senelity and the eventual death ordinarily start seizing the palm after its sixtieth year when a steady decline in the yield of nuts is perceivable. Death of several functional roots, difficulties in absorbing and conducting adequate supplies of nutrients across a tall stem and the increasing hazards due to wind are some of the factors contributing towards driving an ageing coconut palm to such a situation. However, a new method of air-layering is described by which the crown of even a very old coconut palm may be separated from the rest of its old stem after inducing fresh roots at a convenient portion of the aerial stem and planted as a "young palm", enabling it to overcome the adversities of old age and live for another long fruitful period.

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60. The importance of the aerial roots in *Cocos Nucifera*

T. A. DAVIS, Calcutta.

The roots which emanate from the aerial stem of the coconut, termed aerial roots, are classified into four categories. Of the over 7,000 coconut palms examined under different environments in India, 40% possessed aerial roots and these roots differ from the underground ones in many respects. The palm's capacity to produce aerial roots can be made to serve the scientist and cultivator in several ways. It is possible to rejuvenate even a very old palm by layering and separating its crown for propagation. Also the branches and suckers of certain exceptional palms can be separated and successful clonal propagation effected though in a limited scale.

About 60% of the coconut palms growing under semi-water logged conditions possess aerial roots, which is an adaptation to combat the marshy adverse conditions. This capacity and the good soil binding nature of the roots can help the reclaiming of land from shallow lakes. Many of the manurial trials as well as pot culture experiments with coconut are very difficult to be conducted on account of its massive root system. This difficulty can be appreciably got over by inducing aerial roots by the "box-method" and conducting experiments with the active roots thus induced.

61. Storage of Gamma-irradiated onions.

P. B. MATHUR and N. F. LEWIS, Bombay.

Red Globe onions were irradiated with 6,000 rads of 60 Co/gamma rays at the rate of 1000 rads/minute and stored with appropriate controls at two temperature ranges, viz., room temperature (21-35°C; R.H., 45-90%) and cold storage (15-16°C; R.H., 85-90%). The dose employed was sufficient to prevent the sprouting of onions at both the temperature ranges. There was no difference in the extent of waste between the control and irradiated onions at room temperature. In cold storage, however, no rotting occurred in either of the two lots. After 8 months of cold storage the ascorbic acid content of irradiated onions was only slightly lower than that of the controls. There were no adverse effects on colour, texture, taste and pungency of irradiated onions after 8 months of storage at 15-16°C (R.H., 85-90%).

62. Refrigerated storage behaviour of pre-cooled tomatoes.

H. C. SRIVASTAVA, N. V. N. MOORTHY and N. S. KAPUR, Mysore.

Freshly harvested, fully grown, firm green tomatoes *Lycopersicon esculentum* (Mill) Var. Marglobe) were obtained from a nearby orchard and were pre-cooled at 32-35°F till the internal temperature of the fruits reached the ambient temperature. They were then stored at 42-45°F, 47-50°F, and 52-55°F, the relative humidity at all temperatures being 85-90%. The results were as follows :—

1. The physiological losses in weight were the least in pre-cooled fruits stored at 52-55°F.
2. Ripening and colour development was very uniform at 52-55°F.
3. The wastage was less in the pre-cooled fruits at all the three temperatures as compared to the controls and was the least in the treated fruits stored at 52-55°F.

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PLANT PROTECTION

63. Food consumption and adequate bait for Desert Gerbil control.

ISHWAR PRAKASH and C. C. KUMBKARNI, Jodhpur.

Food consumption of *Meriones hurrianae* Jerdon varies from 4 to 5 gms. in 24 hours. The quantity consumed, however, depends on the quality of food. They did not prefer seed diet in captivity. Seeds of 15 plants (*Tecomella undulata, Prosopis spicigera, Prosopis juliflora, Zizyphus numularia, Cenchrus setigerus, Cenchrus ciliaris* etc.) growing in gerbil habitat were tried individually and in mixtures. Trials were made on single gerbil and also in groups. Amongst cereals, wheat and millets were most preferred. Wheat flour was also preferred and can be used as a suitable bait for poisoning the Indian desert gerbil, *Meriones hurrianae.*

64. Microclimate in the burrow of the Indian desert gerbil, *Meriones hurrianae* Jerdon.

ISHWAR PRAKASH and C. G. KUMBKARNI, Jodhpur.

Temperature variations inside the burrow of the Indian desert gerbil, *Meriones hurrianae* were observed with the help of Philips rod thermistors and soil moisture temperature bridge. The thermistor was introduced into the burrow by tying it to the tail of the gerbil. As soon as gerbil rested in the burrow, it got rid of the thermistor by biting the thread off. Thermistors were rarely damaged.

Temperature readings were taken at 50, 100 and 150 cms. horizontally deep inside the burrows. On a hot day the temperature inside the burrow was on an average 6·4°C (±1·0°C) lower than the surface temperature while on a rainy day it was about 4·5°C (±0·7°C) lower than the surface temperature at 50 cms. but the temperature was 3·5°C (±1·0°C) higher at 100 and 150 cms. The temperature variations at 150 cms. fluctuate between 0·5°C (±0·3°C).

65. Toxicity, relative acceptance and lethal dose of certain poisons for the Indian desert gerbil, *Meriones hurrianae* Jerdon.

ISHWAR PRAKASH and C. G. KUMBKARNI, Jodhpur.

Toxicity of various poisons was estimated by oral administration with the help of a hypodermic syringe fitted with a flexible stomach tube. Zinc phosphide is very toxic for *Meriones hurrianae.* An oral dose of 25 mg. in aqueous suspension caused 100% mortality in 3 to 3½ hours. Similarly 50 mg. of Arsenic trioxide killed gerbils in 10-12 hours and 250 mg. of Barium carbonate in 5 to 6 hours.

The relative acceptability (or repellency) of the poisons was measured by the reduction in food intake. There was very little difference in the food intake when Zinc phosphide was administered in concentrations upto 1% of the total bait but at 3%, its acceptability was very low. Arsenic trioxide was unpalatable at 2% concentration but Barium carbonate was readily accepted upto 5% concentration and 10% Barium carbonate was less acceptable. Rodeth and Ratafins were comparatively more acceptable.

The modes of death due to various poisons have been described.

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66. "Nuclear radiations in the control of insect pest of storage."

SNEHAMOY CHATTERJI, P. N. SAXENA, G. R. SETHI and G. W. RAHALKAR, New Delhi.

Nuclear radiations are well known for their harmful effects on the biological tissues. But scientists all over the world have also been vigorously engaged in harnessing them for useful purposes for the benefit of mankind. They have been used as sources for enhancing the yield of agricultural crops and also for the destruction of pests in the field and storage.

In the present communication progress made in the western countries with regard to direct and indirect control of storage pests has been briefly reviewed. It has been suggested that small sources can be effectively used by fractionating the dose instead of a continuous dose from a strong source. It has been observed further by different workers that different insect species differ in their resistance against nuclear radiations. The radiation susceptibility or resistance has been found to vary even with the stage, age and strains in the same species. It has also been pointed out that enough feeding trials would have to be conducted to assess the nutritional quality of the irradiated grains so as to make them acceptable to the consumer.

The property of nuclear radiations to induce sterility in insects has been fully exploited in controlling the screw worm *Callitroga homonivorax* Cqrl. in Curacao islands. This sterile male release technique holds enough promise in the control of storage pests also.

With the installation of 200 curie Cobalt-60 source at the 'gamma garden' of Indian Agricultural Research Institute, New Delhi, work on the use of gamma radiations for the control of insect pests of stored grains has recently been taken up at the Radiotracer laboratory of the Division of Entomology. Experiments are in progress to study the effects of lethal as well as sublethal dosages of gamma radiations on some of the insect pests of stored grains namely, *Trogoderma granarium* Everts., *Tribolium castaneum* Hbst., *Latheticus oryzae* Waterh., *Lasioderma serricorne* Fabr., *Calandra oryzae* Linn. and *Rhizopertha dominica* Fabr. Possibilities will also be explored for the induction of sterility in some of the storage pests, specially those which cannot easily be controlled by conventional methods.

67. Sources of pink bollworm infestation on cotton in Rajasthan.

B. K. SRIVASTAVA and S. P. BHATNAGAR, Jobner.

A study of the hibernating quarters of the Pink Bollworm, *Platyedra gossypiella* Saund. in relation to environmental factors has been made by the authors.

The places where the Pink Bollworm passes the period after the harvest of cotton has been observed as follows :—

(A) In Fields :—

1. Bolls on plants left standing after harvest.
2. Fallen bolls and *Kapas* lying on the surface of the soil.
3. Bolls and *Kapas* lying underground.

(B) In Villages :—

4. Bolls on sticks stored for fuel.
5. *Kapas* and cotton seeds.
   (i) In villager's home.
   (ii) With petty shopkeepers.

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(C) In Ginneries :—

6. *Kapas* and cotton seed.
7. Low grade cotton and heaps of patti.

(D) In Stores :—

8. Ginned seed.

These places form the reservoirs of this pest for the infestation of the next cotton crop.

68. Studies on the post-blossom spray of DDT and Malathion for the control of *Idiocerus niveosparsus* (Mango hopper) and the pesticide residues on mangoes.

P. C. GHOSH, K. KRISHNAMURTHY, S. GODAVARIBAI and S. K. MAJUMDER, Mysore.

DDT and malathion in water-dispersible formulations sprayed at 30 mg/sq. ft., of each insecticide, on tree surface, could control the mango hopper. A single spray at the post-blossom stage was adequate for bringing down the population significantly. Effects of the treatment on fruit drop, insect population and on the growth and yield of fruit, were studied. Residues of both DDT and malathion, were estimated progressively from the time of spraying to harvesting. DDT persisted on the leaf surface even up to 120 days, after spraying. But, malathion disappeared within a few days after spraying. Although, there was no significant difference in the size of the fruits from the treated and control trees, there was significant difference on the total number of fruits and total yield. As against the 14 fruits from the control tree, 36 fruits were obtained from the treated tree. There was no evidence of translocation of insecticide to the edible parts of the fruits, as a result of spraying malathion and DDT on the inflorescence.

69. Field sanitation and infestation control in stored grains.

S. K. MAJUMDER, K. KRISHNAMURTHY and S. GODAVARIBAI, Mysore.

Malathion, water-dispersible formulation was sprayed on the ripe grain inflorescence before harvest in different Sorghum plots. With a permissible concentration of 8 ppm on grain at the time of bagging, the persistance and biological efficacy of the chemical in post-harvest storage were studied. Infestations caused by *Calandra oryzae* and *Tribolium castaneum* were controlled in freshly harvested sorghum by the pre-harvest spray treatment on the panicles. Impregnation of gunny bag with Lindane-DDT water-dispersible formulation was found to have residual life for a period of 8 months. Panicles or sorghum treated at the permissible level of 8 ppm of malathion in the pre-harvest period and the threshed grains stored in these insect-proofed gunny bags could keep the grains free from insect infestation. Criteria like kernel damage, viability, fat acidity, water soluble acidity, microbial count, uric acid content and insect population, were assessed. These have indicated the general soundness of the grain stored with the pre-harvest prophylactic treatment.

Paddy, sorghum and pulses showed promise for insect-free storage by the prophylactic spray treatment on grains and insect proofing of receptacles. This technique of storage of grains can be carried out by producers in rural areas where fumigation can hardly be applied without the help of trained personnel.

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70. Some prevalent plant diseases in Sikkim-1.

N. C. JOSHI, Calcutta.

The present paper gives a preliminary account of the survey of various diseases occurring on plants, in order to have some idea about their occurrence and distribution, in different parts of Sikkim.

40 fungi, two bacteria and one virus have been recorded in this paper. Among the fungi, eight are Phycomycetes, nine Ascomycetes, ten Basidiomycetes and 13 Deuteromycetes. The virus disease on Cardamom (*Amomum subulatum*) which is commonly called 'Foorkey' disease by the local people in Sikkim and West Bengal is of great economic importance.

71. Effect of sugarcane bud-diffusates on germination of chlamydospores of *Ustilago scitaminea* Syd.

S. K. SAXENA and ABRAR M. KHAN, Aligarh.

The effect of bud diffusates obtained from Co 245, Co 515 and Co 313 varieties of sugarcane was determined on the germination of chlamydospores of *Ustilago scitaminea* Syd. But diffusates stimulated the germination of chlamydospores. No difference was observed in the bud diffusates obtained from these varieties with respect to germination of chlamydospores. Highest germination occurred when diffusates were drawn from 10 buds in 10 ml. distilled water after 12 hours.

72. Studies on Helminthosporium disease of Rice—VI. Nutritional factors and disease expression—Effect of leaching of soil on incidence.

N. K. CHAKRABARTI and S. Y. PADMANABHAN, Cuttack.

An experiment was carried out to find out the reaction of rice plants grown on leached soil to infection by *Helminthosporium Oryzae*. Two resistant (Ch. 13 and BAM. 10) and two susceptible (Benibhog and Latisail) varieties were used in the experiment. The soil was leached at about the boot leaf stage of the varieties. After leaching N, P, K, were added in various combinations. The plants were infected artificially with the spore suspension of *Helminthosporium Oryzae* a week after leaching and addition of nutrients. Observations on leaf infection were recorded after ten days.

It was observed that the infection was higher in the plants grown in leached soil when compared with those grown in unleached soil; secondly, plants which had received addition of N alone after leaching had higher infection than those growing on leached soil without such an addition; plants which had received N & P and P & K, after leaching had lower infection than those which had received N alone.

73. Studies on Helminthosporium disease of rice—VI—Nutritional factors and disease expression—2. Effect of potassium.

S. Y. PADMANABHAN, C. T. ABICHANDANI, N. K. CHAKRABARTI and S. PATNAIK, Cuttack.

An experiment was carried out to study the development of helminthosporium disease on rice under different levels of potassium. The plants were grown under three levels of K_2O in culture solution, viz., (1) K_2O-0, (2) K_2O 10 p.p.m. and

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(3) K_2O 20 p.p.m. T. 141, a variety resistant to helminthosporiose was used. It was observed that the infection was significantly more in the plants which had not received any K_2O in the solution. Within individual plants, the flag leaf had least infection and the intensity of infection in the flag leaf was not different in the three treatments; the infection was significantly higher in the second and third leaf from the top in the no K_2O plants when compared with those plants which had been supplied with 10 p.p.m. and 20 p.p.m. K_2O.

The number of ear-heads, yield of grain and straw were very low in no K_2O treatment, in comparison to the other two treatments. There was 0·26% K_2O in the grain, 0·43% K_2O in the straw in the plants which had not been supplied with K_2O in the culture solution. The K_2O content of plants which had received K_2O in culture solution was comparatively very high (0·44% and 1·58% in grain and straw respectively in plants under 10 p.p.m. K_2O and 0·82% and 2·50% in grain and straw respectively in plants under 20 p.p.m. K_2O).

74. Control of blast disease of rice with fungicides. V. Use of antibiotics for the control.

S. Y. PADMANABHAN, J. VEERARAGHAVAN and K. V. S. R. KAMESWAR ROW, Cuttack.

A field experiment was carried out to find out the efficacy of three antibiotics (viz. Antimycin A, Blastimycin and Central Rice Research Institute antibiotic, obtained from a species of Streptomyces, which was found to inhibit growth of *Piricularia oryzae*) in the control of blast disease of rice. A cupro-mercurial fungicide MCO mercurised copper oxychloride was employed as a standard. The experiment was conducted with the rice variety Co. 13, highly susceptible to blast. The infection was negligible in the sprayed plots, whereas in the control slight foliar infection was present. The sprayed treatments were associated with higher yields than the control.

75. Relative efficiency tests with stickers and spreaders in control of potato late blight in Himachal Pradesh.

S. S. JAIN and P. K. SETH, Solan.

The potato crop in Himachal Pradesh suffers heavy losses from late blight almost every year particularly in areas of high elevations where most of this crop is grown. In such areas, heavy rains cause considerable depletion of the fungicidal deposit on the leaves, when no adhesive is used with the spray mixture. Tests with stickers and spreaders such as Triton B-1956, (8 oz./100 gal.), wheat flour (8 oz./12½ gal.), linseed oil (8 oz./100 gal.), Tenac (1 part to 3 parts of the dry fungicide by weight), and Albolineum (8 oz./100 gal.), used as additions to 0·3% Copper Sandoz were conducted under severe conditions of the disease during the period from 1958 to 1961 at the Regional Potato Development Station, Shilaru (8,500′ m.s.l.) with an annual rainfall of about 70 inches in Mahasu District, to assess their relative efficiency in improving control. Spraying was carried out on variety Up-to-Date at the rate of about 100 gallons per acre four times during July and August at fortnightly intervals. The first application was given in the 1st week of July as a prophylactic measure. The total yield of individual plots was recorded. Good results were obtained with all the stickers and spreaders under test. Triton B-1956 gave the highest yield (161·6 mds./acre), followed by wheat flour (141·8 mds./acre), linseed oil (141·6 mds./acre), Albolineum (141·0 mds./acre) and Tenac (140·5 mds./acre), as compared to the control (110·9 mds./acre),

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the percentage increase in yield over the control being 45·7, 27·8, 27·6, 27·1 and 26·7, respectively. Amongst the last four stickers and spreaders, which were notably superior to the control, exceeding in yield by 29·6 to 30·9 mds./acre, hardly any significant difference in efficiency was detected. The percentage increase in yield with different stickers and spreaders ranged from 26·7 to 45·0 over the untreated.

76. Studies on the effect of seed-dressings on germination and yield of wheat.

S. S. JAIN and P. K. SETH, Solan.

Field tests with different mercurial and copper seed-dressing such as Agrosan GN, Ceresan, Hexasan, Tillex, Copper carbonate and T.B. 4452b were conducted at the Government Research Station, Dhaula-Kuan (1,800′ m.s.l) in Sirmur District, to study their comparative efficiency in improving germination and yield of the three recommended wheat varieties, viz. NP. 809, NP. 792 and Ridley. The seed was treated with different fungicides at 4 oz./cwt. for 30 minutes, and was sown 10 days after treatment. Germination was recorded 3 weeks after sowing while the yield data was recorded at the time of harvest. The results indicated that with the exception of T.B. 4452b, none of the fungicides had an adverse effect on germination of wheat seed. Agrosan GN, Ceresan, Copper carbonate and Hexasan showed a slight stimulatory effect, while in the case of T.B. 4452b a slight inhibitory effect was observed. Tillex was at par with the control. Higher yields were obtained with seed treated with all the fungicides. Hexasan, Copper carbonate and Tillex proved outstanding in increasing yield, followed by T.B. 4452b. and Agrosan GN. Ceresan, though least efficient, was slightly better than the control. The increase in yield over the control was more than a maund per acre in the case of Hexasan, Copper carbonate and Tillex, the figures being 1·37, 1·33 and 1·07 mds., respectively. The increase in yield with T.B. 4452b, Agrosan GN and Ceresan was relatively small.

77. Comparison of seed-dressings in control of hill bunt *(Tilietia Foetida & T. Caries)*.

S. S. JAIN, Solan.

Hill bunt of wheat, caused by *Tilletia foetida* and *T. caries*, is largely prevalent at higher altitudes (5,000′ to 10,000′ m.s.l.) in Himachal Pradesh and causes heavy losses to wheat crop particularly in the drier areas like Kalpa and Pangi. Field tests with different mercurial, copper and sulphur seed-dressings were conducted at Shillaru 8,500′ m.s.l.) in Mahasu District during 1957-58 to 1959-60, to evaluate their comparative efficiency against bunt. Seed of a local wheat variety was artificially inoculated with bunt spores in the ratio of 1 :192 and thoroughly mixed for about 10 minutes. The inoculated seed was subsequently treated with different fungicides at 4 oz./cwt. for 30 minutes, and was sown 10 days after the treatment. The percentage incidence of the disease was recorded at the time of harvest by counting the total number of healthy and bunted ears. The results indicated that all the fungicides under test were effective in reducing the incidence of bunt. Hexasan, Agrosan GN, Ceresan and Copper carbonate gave an excellent control of the disease, the percentage infection being 0·003, 0·02, 0·02 and 0·14, respectively. Next in efficiency were Tillex and Sulphur dust, both being at par with 1·14% and 1·55% infection, respectively. Lunasan, though least effective, was notably superior to the untreated, and reduced the percentage infection of bunt from 20·81 in the control to 4·3 Sulphur dust, although slightly less effective than other

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mercury and copper seed-disinfectants tried, was found to be much more economical because of its low cost.

78. Tests of fungicides for control of peach leaf curl (*Taphrina deformans* Tul.).

S. S. JAIN, Solan.

Peach leaf curl, caused by *Taphrina deformans* Tul., is widely distributed in Himachal Pradesh and causes heavy damage to peach crop in cool, humid areas. Field tests were conducted at Bhangrotu (2200′ a.s.l.) during 1957 to 59, and at Mashobra (8000′ a.s.l.) during 1958 and 59 to asses the comparative efficacy of 13 proprietory fungicides with organic, copper and sulphur base, and also to determine whether these could approach in efficiency to that of Bordeaux mixture and lime-sulphur against leaf curl. All the proprietory copper fungicides were used at 3 lb./100 gal. The treatments were applied only once just prior to bud movement, the spray being applied @ ¾ to 1 gallon per tree. The trees were examined for disease incidence towards the end of April or early May. The results indicated that all the fungicides under test appreciably reduced the incidence of leaf curl, but none of them could give an absolute control. At Bhangrotu, lime-sulphur (1 :10) and Bordeaux mixture (5 :5 :50 or 4 :6 :50), on the whole, proved to be most effective, the average number of diseased shoots per tree being 2·05, 2·06 and 2·00, respectively. Among the proprietory copper fungicides, Fytolan and Cupravit were slightly superior to Perenox, Fungi copper, Blitox and Shell copper, the disease incidence being 2·2, 2·9, 3·0, 3·3, 3·4 and 4·03, respectively. Amongst the proprietory wettable sulphurs, Thiovit (0·6%), Spersul (0·6%) and Solbar (1%), which gave equally good control, were slightly superior to Hexamar wettable sulphur (0·6%), the infection being 2·08, 2·08, 2·09 and 2·55 respectively as against 6·32 in the control.

At Mashobra, where leaf curl was more severe, Cupravit and Fytolan provided slightly better control than Blitox, Cupramar, Bordeaux mixture (4 :6 :50) and Shell copper, the infection being 3·5, 5·4, 6·6, 7·7 and 12·2, respectively. No significant differences in efficiency were detected amongst Thiovit, Spersul, lime-sulphur (1 :10) and Solbar, which were superior to Ultra sulphur (0·2%) and Hexamar wettable sulphur, the disease incidence being 5·4, 6·2, 8·1, 8·5, 12·0 and 12·2, respectively. Dithane M-22 (0·2%) did not appear to be as efficient as other fungicides, but was markedly superior to the control, the infection being 22·0 and 35·2, respectively.

79. Studies on cultivation of *Pleurotus Sp.* on paddy straw.

(Miss) ZAKIA BANO and H. C. SRIVASTAVA, Mysore.

Cultivation of *Pleurotus sp.* on various media was tried and it was found that paddy straw soaked in water overnight gave the best results. Jowar stems, hard and soft wood sawdust, paddy hulls and their combination did not give good yield. Low quality cereal grains and pulses were used as a source of nutrient @ 3% of the straw. There was a noticeable increase in yield when red gram and Bengal gram powders were used @ 2 and 3% respectively. Use of 1% superphosphate as a source of phosphorus along with red gram powder gave higher yield. There was no effect on the increase of yield by addition of ammonium sulphate and urea, when used in 0·1 to 0·5% concentration. It was found that as the quantity of straw was increased per bed, there was a noticeable increase in yield. In 400 to 600 gms. of straw per square foot, even three crops were harvested, but on increasing to 800 and 100 gms., the yield decreased.

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80. Factors Influencing Incidence of Stem-rot in *Corchorus capsularis*

T. GHOSH and A. K. MONDAL, Barrackpore.

It has been suggested that use of ammonium sulphate balanced by requisite amount of potash prevents incidence of stem-rot in *Corchorus capsularis* caused by *Macrophomina phaseoli* (Maubl.) Ashby. In a composite trial in grey alluvial tract the use of ammonium sulphate coupled with potassium chloride failed to prevent stem-rot. Soil analysis showed that the pH of the sick plot was 5·8 as against 6·6 in the unaffected plot. The exchangeable calcium was more in the latter than in the sick plot. There was no other significant difference. It is, therefore, felt that a basal dressing of lime might reduce incidence of stem-rot in jute.

81. Comparative Incidence of Diseases in 'Kenaf' and 'Roselle' under field conditions.

T. GHOSH and N. MUKHERJEE, Barrackpore.

The incidence of diseases and damage due to them in Kenaf (*Hibiscus cannabinus*) and Roselle (*H. sabdariffa*) grown under similar conditions in a field trial show that Kenaf which is a near substitute of jute suffers heavily from brown rot due to *Volutella* sp. and anthracnose due to *Colletotrichum hibisci* Poll, while Roselle is susceptible to foot and stem rot due to a new strain of *Phytophthora parasitica* Dast.

GENERAL

82. Further Studies of Leaf Morphogenesis in Relation to Important Growth Phases of Rice Plants.

B. SAHA, Barrackpore.

In relation to the initiation of culm elongation and of ear formation in certain paddy varieties, the relative lengths of leaf sheath and blade were found to vary. To find whether similar relations were general for several rice plants, sown in different months throughout the year, the present investigation has been undertaken.

Seeds of *Bhasamanik* (aman), *Ashkata* and *Satika* (aus) and *C.B.I.* (boro) were grown in petri dishes and on germination transferred to the big earthen pots in triplicate. The aman variety was sown every fifteenth day of the months, from March to August, 1960, and the other three varieties on almost the same date of every alternate month all the year round. Most of the various aspects including duration, plant height, total number of leaves, culm elongation, ear formation, harvesting, panicle length and number of grains per ear of the main culm of the individual groups of sowings were carefully recorded.

Most of the results indicate that the variation of relative lengths of leaf sheath and blade with respect to the above two growth phases e.g. culm elongation and ear formation, was very evident in nearly all the sets. Besides these, (i) the total number of leaves of a variety varied with the duration and the time of sowing, the variability being more in season-bound aman than that in the period-bound aus and boro paddies; (ii) in almost all the sets of *Bhasamanik*, the mean plastochrone interval between the development of two successive foliar organs was nearly ten days, (iii) the extent of hard culm phase was relatively consistant in the individual variety, but that of the early culm elongation phase occurring before ear initiation was extremely variable and from morphogenetic point of view this latter one is very important.

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SECTION OF PHYSIOLOGY

President :—G. C. Esh, M.Sc., Ph.D. (Ohio), F.N.I.

Abstracts

BLOOD AND CIRCULATION

1. *In Vitro* effect of Hydrolyzed Glucose Cycloacetoacetate on Coagulation of Blood in normals and patients suffering from Metabolic Diseases.

M. C. NATH and INDU VAISHWANAR, Nagpur.

Glucose cycloacetoacetate (GCA) hydrolysate, methionine, choline, vitamin B_{12}, inositol and ascorbic acid when added separately to plasma and incubated were found to cause inhibition of stypven time. The inhibition of clot formation was more pronounced in case of hydrolyzed glucose cycloacetoacetate and choline and moderate with methionine and other substances. Such inhibitory action of glucose cycloacetoacetate hydrolysate and choline on clot formation was counteracted by increased concentration of factor VII only. The effect observed was due to an interference in the conversion of prothrombin to thrombin.

2. Fibrinolytic activity of the blood in experimental and clinical tuberculosis.

Mrs. V. V. CHIPLUNKAR and M. SIRSI, Bangalore.

Though the physiological role of the fibrinolytic system in the blood is far from clear, this lytic activity of the blood is considered to play a prominent role in dissolution of the intravascular clot in wound repair and in haemorrhagic diathesis. In acute experimental tuberculosis of guinea pigs a significant increase in the fibrinolytic activity is observed. This condition is associated with an increased fibrinogen level and thus differs from the enhanced lytic activity accompanied by afibrinogenaemia as seen in certain disorders of pregnancy.

No enhancement of the fibrinolytic activity was seen in the blood of chronic tuberculous patients. Since they were on antituberculous drugs and vitamins therapy, the interfering influence of these compounds on the lytic actions of the disease as such, needs elucidation.

3. A New Method of Isolating Active Globulins from Native Antitoxic Plasma.

S. K. DUTTA, Calcutta.

During immunisation of horses with Welchii gasgangrene toxoid, the antitoxic property is well distributed over the γ- and β- globulins. In order to probe into the nature of these antibodies, primary problem is to get them in pure form, which was still a problem. A simple and efficient method has been worked out. Native antitoxic plasma is precipitated with ammonium sulphate (at 15% conc.) to remove some non-specific bodies. The clear solution is subsequently treated with sodium chloride (to 30% conc.) under which condition the antibodies are completely precipitated. The harvested precipitate is triturated in McIlavain buffer (pH 3·2) to remove the residual unwanted proteins remaining undissolved. The clear buffer

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solution is finally retreated with ammonium sulphate (at 15% conc.) to precipitate down the pure antibodies. The antitoxins thus obtained is free from salts by electrodialysis using chromate-gelatin membrane. The antitoxin containing both γ- and β-globulin is then mixed with folic acid to precipitate down the strongly basic γ- globulins, leaving the less positively charged β- globulin in solution. Each component was freed from folic acid by equilibrium dialysis.

4. Studies on the Properties of Vinyl pyrrolidone polymer as a physiological transfusion material.

S. K. GANGULY, Calcutta.

Studies have been made on the effect of heat on the physiological solution of the polymer. The alteration of the polymer by way of change in pH by heat treatment has been observed which could be retarded by nitrogen and buffer solution. A paper chromatographic study has been made and attempted to detect the alteration of the polymer by using 95 per cent (v/v) alcohol as solvent and locating the spots of the iodine-complex by spraying with iodine solution.

The average molecular weight of the polymer was measured by intrinsic viscosity as well as by osmometric method. While different batches of polymer of a particular range of molecular weights have been used in the preparation of the solution for transfusion, the measurement of the average molecular weight of the individual batch of the product is considered essential and at the same time, a verification of the uniformity of the composition of the polymer by observing the behaviour of the solution of different batches in respect of viscosity, surface tension and specific gravity at different temperatures is suggested.

5. Various body fluid compartments in dogs.

M. L. GUPTA and V. B. MATHUR, Jaipur.

Various fluid compartments have been measured simultaneously in 21 dogs kept on a standard diet.

The total body water varied from 5·73 to 9·781 (50 to 70% of body wt.), extracellular fluid from 3·50 to 5·031 (26 to 51% of body wt.), intracellular fluid from 1·62 to 4·611 (20 to 32·92% of body wt.), blood volume from 77·7 to 92·5 ml/kg. body wt., haematocrit from 47 to 60% and plasma volume from 34·9 to 48·1 ml/kg. body wt. E.C.F. values bear an inverse relationship to body wt. but do not show any apparent sex variation.

6. Circulatory and respiratory responses to gastric distension.

M. L. GUPTA, Jaipur.

The effect of distension of various portions of stomach of healthy street dogs anaesthetised with suitable fixed dose of Chloralose with various pressures on circulatory and respiratory functions have been studied.

Distension of body of stomach causes fall of blood pressure with slowing of heart and increase in amplitude of cardiac action potentials. After injecting atropine (0·05 to 0·1 mg./kg. body wt.) gastric distension does not produce cardiac slowing and the depressor response is less marked indicating that the depressor response is possibly due to diminished cardiac output and diminished peripheral resistance. Such distension also causes increase in respiration rate associated with diminution in amplitude and tidal volume. The circulatory and respiratory effects on distension persists without any decrement as long as the distension is maintained. The effects of distension of pyloric and cardiac end of stomach have been similar.

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7. Behaviour of aortal elastic tissue of hypercholesterlaemic animals.

AJIT GOSWAMI and D. P. SADHU, Izatnagar.

The splitting and defraying of elastic tissue begin to occur much before the actual deposition of lipids in the aortic tissue of atherosclerotic animals. The disruption of elastic tissue results in increased distensibility (both radial and longitudinal) of the arterial tissue. The lipid deposition in atherosclerosis occurs predominantly at branching points at particular sites with respect to flow-direction. The deposition of lipids at these points can be explained in terms of decreased damping and by the phase-shift in wave reflection at the branching points of the distensible aorta.

8. Improved methods of Plethysmography.

B. S. KAHALI and M. L. GUPTA, Jaipur.

During the course of our study on the pressor mechanism of gastro-intestinal stretch receptors the common intestinal oncometers were found unsatisfactory : a glass intestinal plethysmograph was improvised from an isolated organ bath tube of wide bore fitted with a rubber collar (a thin rubber sheet with a central hole) at the wide end through which a piece of the intestinal loop of suitable length was introduced into the oncometer. The loop forms a closely tight fitting junction with the rubbed collar. The oncometer was filled with warm tyrode's solution. The narrow stem of the bath was connected with the recording tambour.

The limb plethysmograph, as commonly used with a rubber collar attached to the broad end of the plethysmograph gave very indifferent recording of the pulsatile blood flow into the limb. Instead, a sleeve of the skin obtained by a circular cut of the skin of the limb just proximal to the broad end of the plethysmograph and everted for half and inch all round, was tied over the end of the plethysmograph. This modification of fixing the plethysmograph gave excellent results.

9. A modified technique of blood collection for exygen estimation.

B. S. KAHALI and M. L. GUPTA, Jaipur.

During the course of investigations a new technique has been devised for blood collection. A 10 c.c. luer lock syringe is moistened with a solution containing 600 mg. of sodium fluoride and 100 mg. of heparin in 15 c.c. of 0·85% sodium chloride solution. The excess is expelled and 0·25 c.c. of mercury is drawn into the syringe. It is then connected to the proximal end A of a three way stop-cock. The distal end C is connected to the venous Catheter or the arterial puncture needle. The side end B is connected through a small bored transparent rubber tubing with another syringe. In the beginning A and B are connected and the excess of mercury is expelled from the first syringe through B filling the space from A to D (junction) with mercury. Now B and C are connected and about 2 ml. of blood is drawn into the second syringe, preferably heparinized to facilitate cleaning, attached to B of the three way stop cock. The blood that remains in the space between C and D is not exposed to air but is in contact with mercury filling the space from D to A and the first syringe. A and C are now connected and desired amount of blood is gradually drawn into the collecting first syringe. The stop-cock is then turned to close the syringe which is disconnected and slightly tilted so that the mercury trickles into the nozzle and forms a seal.

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10. Electrocardiographic Studies in Cow-Calves.

S. N. RAY and D. N. MULLICK, Izatnagar.

Seven cow calves were divided into two groups of four and three in each group. The animals in the first group were receiving only milk for the whole of this observation period. The second group of calves was reared first few weeks on milk and afterwards on calf ration. Electrocardiogram tracings were recorded in each animal at monthly intervals. Equipment and methods were the same as have been used for human-beings.

The PR & QRS intervals showed some variation between control and experimental groups whereas very little differences were noted in the amplitudes of different waves. With the progress of observation (five months) the average values of both the groups failed to show any appreciable variation. Some individual calves in milk group demonstrated lower heart rate and smaller amplitude.

DIGESTION AND METABOLISM

11. The effects of gastric distension on gastrointestinal motility and secretion.

M. L. GUPTA, Jaipur.

The influence of gastric receptors on gastrointestinal motility and secretion has been studied on healthy street dogs anaesthetised with suitable fixed dose of chloralose or morphine urethane. Distension of body of stomach causes marked increase in tone and rhythmicity of descending colon and rectum while duodenum, jejunum and ileum show lesser effect. Such distension also causes increase in gastric and duodenal secretion while the rest of the gut is not affected.

The distension of pyloric portion gave similar results except that the biliary secretion was very much increased. The distension of cardiac end also gave similar results associated with diminution of tone and rhythmicity of stomach. The motor and secretory responses are better marked under 20 and 40 than 10 mm. Hg. pressure. When the distension stimulus is discontinued, the motor effects disappear but the secretory effects continue suggesting that the motor effects are due entirely to nervous mechanism while the secretory are due to humoral or dual mechanisms.

12. A study of jejunal and ileal stretch receptors.

B. S. KAHALI and M. L. GUPTA, Jaipur.

The effect of distension of jejunum and ileum of healthy street dogs anaesthetised with suitable fixed dose of chloralose with various pressures on circulatory, respiratory and alimentary functions have been studied.

The effects on the circulation and the respiration were similar to those caused by duodenal distension reported previously but of less intensity. The effects with jejunal distension were more marked than those of ileal distension suggesting a descending gradient of receptor activity. After injecting atropine (0·05 to 0·1 mg./kg. body weight) distension of these regions produced no cardiac slowing indicating that it was entirely a reflex effect mediated via the vagus. However the pressor response was more marked as the rise of blood pressure due to vascular effect was not counteracted by cardiac slowing.

The effects on gastrointestinal motility were similar to those of the duodenal distension that unlike duodenal distension jejunal and ileal distension caused increased motility of the stomach. The duodenum first showed diminution of tone and rhythmicity but subsequently there was increase in tone and rhythmicity with

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jejunal distension. The other regions of the intestines (small and large) responded by increased activity. The jejunal distension showed increased gastric secretion while ileal distension showed slight increase in the beginning but later on no effect was seen. The rest of the gut did not show any secretory change.

13. Studies on Pulse Protein: Part V Enzymatic Liberation of Absorable N from Bengal gram Protein.

T. S. DE, Calcutta.

The primary factor which determines the utilization of a dietary protein is the timely availability of all the liberated N for body metabolism. The rate of release of the total N including α —amino N from pulse protein has been studied by subjecting it to *in vitro* digestion by successive action of the proteolytic enzymes. The rate of liberation of total soluble and α —amino N at all stages of enzymatic digestion seems to be slightly slower with pulse protein in comparison to that with casein protein.

14. Lipogenesis in Adipose Tissue of rats fed different diets.

J. M. KHANADE and M. C. NATH, Nagpur.

Lipogenesis and glucose uptake by epididymal fat pads of rats fed different diets have been investigated. Lipogenesis was found to be depressed in rats fed high-fat, high-protein, thyroid, thiouracil, and thiamine-deficient diets. The same dose of insulin causes varying degrees of lipogenesis in the tissues, depending on the type of diet fed previously. Lipogenesis is above normal in hydrolyzed glucose-cycloacetoacetate-fed rats but glucose uptake is not appreciably affected. The glucose uptake of adipose tissue is significantly depressed in rats fed high fat, high fat with high protein, and Vitamin B_1—deficient diets, and in hypothyroidism. Both hyperthyroidism and hydrolyzed glucose cycloacetoacetate feeding increase glucose uptake by the tissue. Alloxan diabetes reduces lipogenesis as well as glucose uptake.

15. Studies on the effect of feeding some common cooking oils on the lipid fractions of blood plasma of rhesus monkeys.

SACHCHIDANANDA BANERJEE, PULAK KUMAR GHOSH and ASOK BANDYOPADHYAY, Bikaner.

Rhesus monkeys were fed a basal diet containing 2% fat and 15 mg. cholesterol per 100 gm. of the diet and the plasma contents of total cholesterol, ester cholesterol, phospholipid, lipoproteins and nonesterified fatty acids were estimated. Some of the animals were fed 3 gm. cholesterol mixed with the diet with or without the different oils such as mustard oil, coconut oil and sesame oil. Blood constituents of the above mentioned components were estimated at intervals after the different diets were administered. Fecal excretion of sterols were also estimated.

The feeding of cholesterol for a period of 4½ months did not affect the plasma and ester cholesterol. A slight elevation was observed after 6½ months of feeding cholesterol. Plasma cholesterol level rose when the cholesterol fed monkeys were supplemented with mustard oil, coconut oil and sesame oil but the rise was maximum in the animals fed sesame oil. Up to the third month of the experiment the fecal excretion of the sterols did not change in the animals fed cholesterol with or without mustard oil or coconut oil. The excretion diminished from the third

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month in animals fed sesame oil and the diminution was maximum in the sixth month. The excretion diminished from the fourth month in the group receiving coconut oil and from the sixth month in the group receiving mustard oil. There was no change in the lipoprotein fractions. The plasma nonesterified fatty acids increased after cholesterol fteding and when cholesterol was fed along with sesame oil the rise was maximum.

The results indicated that saturation or unsaturation of the oil probably are not concerned with the absorption and consequent elevation of plasma cholesterol. Some constituents of the oil other than its saturation or unsaturation are possibly responsible for the absorption of cholesterol. A considerable rise in the nonesterified fatty acids of plasma along with a rise in the cholesterol level suggests a direct relationship of both these constituents of plasma.

16. Effect of Tetracyclines on Carbohydrate and Lipid Metabolism.

SACHCHIDANANDA BANERJEE, K. G. PRASANNAN and PULAK KUMAR GHOSH, Bikaner.

Glucose tolerance was lowered in rabbits and rats after the animals were fed terramycin, 5·7 mg./100 gm. body weight/day, for 6 days. Liver glycogen also diminished in rats under terramycin treatment. No such effects were observed in rats similarly treated with achromycin.

There was increased cholesterol content of the whole body of rats treated with terramycin or achromycin indicating increased biogenesis of cholesterol after the administration of the antibiotics. Phospholipid contents of various tissues increased after treatment of the rats with terramycin or achromycin although the phospholipid turn over in the whole body did not change.

17. Tissue respiration in cystine-fed rats.

IVA CHATTERJEE, B. B. GHOSH and D. P. SADHU, Calcutta.

Cystine fed to rats produces fatty liver, especially with a low protein diet. Cystine increases growth rate of tissues, thus increasing the requirement of labile methyl groups and thus resulting an induced choline deficiency and fatty liver. Tissue respiration of liver and kidney slices has been studied in control rats fed on synthetic complete diet and the experimental rats fed on additional dose of cystine in their diet daily. Histochemical observations have demonstrated fatty liver in cystine-fed rats. The liver QO_2 to succinate substrate was increased in cystine fed rats, but QO_2 of liver and kidney to pyruvate or succinate substrate showed a decrease in experimental animals. A possible mechanism of decrease of tissue respiration is discussed.

18. Effect of Vitamin B_{12}, unsaturated fat and Hydrolyzed Glucose Cycloacetoacetate on bile acids excretion in experimental Hyperlipemia.

M. C. NATH and D. M. BRAHMANKAR, Nagpur.

The effect of vitamin B_{12}, unsaturated fat and hydrolyzed glucose cycloacetoacetate (GCA) on the total plasma cholesterol levels and on the excretion of fecal bile acids has been studied in rats in which hyperlipemia was induced by feeding saturated fat. These substances have been found to increase the output of fecal bile acids with a concomitant fall in total plasma cholesterol levels, thus indicating their important role in increasing the metabolism of cholesterol in the living system through its conversion to bile acids. Hydrolyzed GCA was found to be most effective in this process.

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19. Studies on Pulse Protein: Part VI Tissue Nitrogen on Pulse Diet.

T. S. DE and G. C. ESH, Calcutta.

Tissue growth and maintenance of its nitrogenous integrity are important functions of dietary nitrogen. This paper reports the nitrogen content of various body organs of rats fed and maintained on pulse and casein protein diets. The extent and rate of regeneration of tissue nitrogen was followed in protein-depleted adult rats during repletion on these protein diets. During growth the distribution of nitrogen was found to be greater in almost all the organs with casein protein diet. Each organ seemed to have its own individual tempo with respect to the quality of dietary N in the process of disintegration and regeneration. On repletion all the depleted organs, however, seemed to regenerate at a little slower rate on pulse protein diet than on casein protein diet.

20. Effect of Pulse Protein diets on the Transaminasing Activity of plasma and other tissues in rats.

J. M. SOM and G. C. ESH, Calcutta.

The levels of aspartic-glutamic and alanine-glutamic transaminase activities of plasma, liver, heart and kidney have been studied in growing rats maintained on pulse protein and casein diets at different levels of protein intake. Similar enzyme activities were followed in adult rats after protein depletion and repletion on these two test protein diets. The enzyme activities are depressed at the lowest level (6%) of protein intake and such depression is more prominent in case of pulse protein diet and in alanine-glutamic transaminase activity particularly in the liver and heart. Partial protein depletion results in the significant lowering of enzyme activities in the liver, more so in alanine-glutamic transaminase activity which can be effectively restored by feeding 18% casein protein diet for 4 weeks but less effectively by pulse protein diet. The significance of the changing transaminase activities under different protein feeding conditions has been discussed in relation to the utilization of dietary proteins.

21. On the study of the changes in the chemical composition of blood and liver tissue in partially hepatectomized animals.

M. L. PAI, Baroda.

Some of the changes in the chemical composition of the liver during regeneration in laboratory rats after partial hepatectomy have been studied in an attempt to find a correlated chemical description of regenerative growth of the liver tissue in these animals. The changes in the chemical composition of the blood of these animals were also observed and compared with the changes in the chemical composition of the liver tissue during regeneration. It was observed on comparing the composition of the regenerated tissue with that of the corresponding normal liver tissue on dry weight basis, that the chemical constituents, e.g. total proteins, albumin, globulin, and total lipids were restored to normal or nearly normal during the period of 8 days after the operation for partial hepatectomy. On comparing the composition of blood of normal and hepatectomized animals, with the composition of liver tissue, both normal and regenerated, it was found that the blood constituents studied were coming to normal, as was seen in case of the chemical constituents of the regenerating liver tissue, which were like-wise observed to be coming to almost the normal level during the period of eight days after the operation for partial hepatectomy. The significance of the above findings has been discussed in the paper.

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22. Determination of body surface area in Indian Hindu Children.

SACHCHIDANANDA BANERJEE and ASHIM KUMAR BHATTACHARYYA, Bikaner.

Body surface area (BSA) was measured in thirteen Indian Hindu Children, of ages varying between 3 and 12 years, with tape and surface integrator. In 9 out of 13 children the results obtained were lower than the body surface area (BSA) calculated with the weight-height formula of Du Bois and Du Bois. Based on the actual measurements a new constant for the weight-height formula was obtained and a new equation, Surface Area (cm^2) = Weight $^{0.425}_{(kg.)}$ × Height $^{0.725}_{(cm.)}$ × 70, has been suggested for the BSA of Indian children. A nomogram for reading off surface area in metric units based on the above formula was prepared. A significant difference existed between the BSA calculated with new formula and that of Du Bois and Du Bois.

23. Studies on the Efficiency of the Athlets in Sports.

SUSHILRANJAN MAITRA, SANKAR NATH KOYAL and SHAKUNTALA GUPTA, Calcutta.

In sports the persons are grouped according to the age or height and the efficiency is recorded according to the position the subject occupies. But what is the work load on the man is not taken into consideration normally as with the higher work load a person is put to a premium with the person who is working with a lower work load for the same event of the sports. We undertook the study to find out the relation of work load and the efficiency of a person in any event.

The subjects were selected from the Calcutta University sports, who are supposed to be the trained athletes and also from the students of University College of Science and Technology, taken at random. 15 male and 5 female subjects were taken and following records were noted in 100 and 50 metres run respectively. The ages were usually between 20—25 years, height between 150—175 cm. weight 39—57 kg., initial pulse rate 68—100 per minute, final pulse rate 147—180 per minute, initial ventilation rate 8·5 litres to 35 litres per minute immediately after the run. The time taken for the heart rate to come to normal is between 10—20 minutes in sitting relaxed condition, after the events.

The actual work performed per unit second of time in kg. per second plotted in the graph which is obtained by body weight × distance travelled. It is very interesting to note that the candidate who stood first has done the minimum work in kg. per second in comparison with the candidate who stood last and has done maximum work.

It would have been more logical if all the persons were put to same load of work. According to the study it will be better perhaps if the efficiency is to be judged clearly and scientifically by putting the same work load to a particular height groups or age groups.

24. Maximal Working Capacity of Persons Between 20-25 Years And Its Relation to Blood Lactate Concentrations.

SUSHILRANJAN MAITRA and SANKAR NATH KOYAL, Calcutta.

Fatigue is produced when a person is put to his maximum working capacity and this phenomenon produces changes in blood constituents and of these lactate may vary from person to person with respect to his working condition. How far

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the fatigue as noted by external symptoms as also the heart rate and respiratory rate has a particular relation with blood lactate concentration with average young man of our country will be an interesting point of study. Various data are available from foreign countries. In these experiments we have selected 20 Post-graduate students. The subjects were put on the bed at a room temperature of 28°C in a completely relaxed condition both in physical and mental rest. 5 c.c. of blood was collected from each subject, out of which 3 c.c. was separated for determination of lactic acid and 2 c.c. for other estimations. The lactic acid concentration of the resting blood was found to be 18 to 22·5 mg.% with an average value of 20·0 mg.%. The standard deviation and standard error of mean appear to be ±2·94 and 0·73. The lactic acid concentration of the blood immediately after the work was 54 to 101·1 mg.% with an average value of 78·11 mg.%. The standard deviation and the standard error of mean of this analysis were found to be ±12·1 and 3·02 respectively. The values of lactic acid after the work are generally low and it is difficult to say whether the subjects have strained themselves to the real fatigue point. The difference in alkali reserve does not seem to be essentially important for reaching high lactate concentration. The lowering of buffering action by injection of ammonium chloride has got no relationship with work or blood lactate concentration. The rise of lactic acid concentration depends on the amount of work done anaerobically and consequently it depends on the adaptation of the respiration to carry the necessary oxygen to the working muscle. With the subjects the work load was 900 kg. per minute and the steady state was reached for a very short period of time. This shows the respiratory and circulatory adjustment is geared to a lower grades of work and consequently this 900 kg. metres work is proving to be a high grade of work to these subjects.

25. Analysis of Physical Performance and Growth Characteristics of Bengali School Going Boys.

SUSHILRANJAN MAITRA and SANKARNATH KOYAL, Calcutta.

Random subjects of 100 school-going boys from a residential school in south Calcutta, ages between 7-17 years, were taken and their age in years, body weight in kg. height in cm. chest diameter in inches etc. were recorded. The results of this study are plotted on an arithmetic graph paper taking age groups, as the abscissa and height as ordinate. Similarly, other findings of weight, pulse rate, respiratory rate, vital capacity, sitting height, chest girth, jumping height etc. are plotted against the age groups as abscissa. A parabolic type of curves was found. It is very interesting to note that the increase in vital capacity is not always proportional to chest girth. It has been found that the jumping height does not increase with age, but there is a relationship between jumping height and height. From the literature of the foreign countries it seems that there is a better relationship if the trunk length is taken as abscissa instead of total height.

26. Physical Development of Bengali School Children.

P. N. SENGUPTA, Calcutta.

In an investigation under the auspices of UNESCO, 1092 boys and 210 girls of 5 to 15 years age groups, reading in schools and living in rural and industrial areas of West Bengal, were measured for stature and weight for determining their nutritional status and physical development. The measurements were classified according to three groups of subjects : Groups I & II—Hindus and Group III—Muslims. The average measurements corresponding to each age group of these boys and girls were calculated along with standard deviations.

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The group I boys were taller at each age but the group II boys were heavier up to 10 years age and thereafter their development had downward trend. The overall growths of group I boys in stature and weight were highest as compared with those of the boys of other groups. The overall growths of all the boys and girls from 5 to 15 years age in stature and weight were respectively 54·7 cm. and 47·5 cm. and 26·1 Kg. and 25·8 Kg. The indices of nutrition and body build reveal satisfactory developments in groups I and II. The developments of Bengali boys have been compared with those of the boys of other countries.

VITAMINS AND HORMONES

27. Studies on the Ascorbic Acid status in Hypervitaminotic A Rats.

SUDHINDRA CHANDRA RAY and D. P. SADHU, Izatnagar.

Fiftyfour male albino rats weighing about 60 g. were divided into three series. In series I, 18 rats were divided into three groups of (1) control rats fed stock diet ad lib, of (2) hypervitaminotic A rats fed 30,000 I.U. vitamin A per day and of (3) pairfed rats fed the same amount eaten by the hypervitaminotic A rats. Ascorbic acid content of 24 hours urine was estimated and the excretion initially was found to be increased followed by a decrease, while in the tissue such as liver, kidney, brain and suprarenal there is a decrease. In series II ascorbic acid saturation test was made by feeding one mg. ascorbic acid per 100 g. body weight and the hypervitaminotic A group showed reduced excretion in urine. In series III the rats were fed 1 mg. ascorbic acid per 100 g. body weight for 6 days and the hypervitaminotic A rats excreted larger amount of ascorbic acid in urine and showed a smaller content in the tissue. It is concluded that hypervitaminotic A reduces the power of utilization of ascorbic acid in the tissue.

28. Interrelationship of Dietary Protein and Vitamin A in Metabolism: Part IV. Effect of low and high intake of Vitamin A on the maintenance requirement of Dietary Nitrogen in Rats.

R. K. BHATTACHARYA and G. C. ESH, Calcutta.

Young adult male rats after being made vitamin A deficient were fed two dietary levels each of casein and Bengal gram proteins. Both the levels were associated with negative nitrogen balances. The linear relationship between truly absorbed nitrogen and nitrogen balance was described by regression equations fitted to the data by the method of least squares.

Effect of low and high intake of vitamin A on the amount of truly absorbed nitrogen (corrected for the metabolic nitrogen in feces) required for nitrogen equilibrium was computed from these regression equations to be 4·20 and 3·47 mg. of casein nitrogen and 5·07 and 4·11 mg. of Bengal gram nitrogen per day per basal calorie, respectively. The amount of truly absorbed nitrogen required for the maintenance of constant body weight on feeding low vitamin A was found to be 6·92 mg. of casein nitrogen and 7·83 mg. of Bengal gram nitrogen; while, when fed high vitamin A, the amount required were 5·23 mg. of casein nitrogen and 5·88 mg. of Bengal gram nitrogen, the values being expressed per day per calorie of basal heat.

True digestibilities of both the proteins tested in low and high vitamin A fed rats were not different, whereas biological value and net protein utilization of both

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the proteins are lowered in rats fed low vitamin A when compared to the values obtained from rats fed high vitamin A.

The results thus indicate the extent of vitamin A intake significantly affects the metabolism of dietary proteins for their effective utilization.

29. Vitamin A Metabolism in Normal Subjects.

M. L. GUPTA and R. L. AJMERA, Jaipur.

Metabolism of vitamin A in 10 normal Indian subjects of low income group was studied. The resting plasma levels of vitamin A and carotenoids were 48·7±4·8(29·4—84·8) and 69·5±7·5(41·2—112·5) μg % respectively. The concentration of vitamin A is more or less similar to the observations of foreign workers, while carotenoid concentration is appreciably lower than in the foreign subjects (average 137 μg %), possibly due to low dietary intake of provitamins by Indians. None of the subjects excreted vitamin A or carotenoids in urine.

Vitamin A tolerance was studied by giving orally a massive dose of 3 lac I.U. vitamin A (Glaxo). 5 hours after the test dose the plasma level of vitamin A rose to 152·5±6·3 μg % and came down to 56·1±6·1 μg % in 24 hours. The plasma carotenoid level after 5(70·5±7·3 μg) and 24 hours (66·6±6·1 μg) did not show any significant change. No vitamin A or carotenoids were excreted in urine after the test dose except in one case who excreted 16·1 μg. of vitamin A in 24 hours which may possibly be due to some sub-clinical renal damage.

30. Effect of different spices on Thiamine Synthesis in Rats.

M. C. NATH and S. K. MEGHAL, Nagpur.

Mustard when given at the level of 2% in the diet replacing the same amount of sucrose in thiamine inadequate diet, could increase the urinary and faecal excretion of thiamine in rats with greater storage of thiamine in tissues. It also increased the cecal coliform count thereby indicating that mustard helps in the intestinal synthesis of thiamine. Dry ginger also increased the urinary and fecal excretion of thiamine up to 4th week after which it was reduced. The turmeric had no enhancing effect on the biosynthesis of thiamine while the black pepper fed animals could not survive during the experiment on such a high level (2% of the diet).

31. Liver Transaminase Activity in Riboflavin Deficiency.

S. C. JAMDAR and SAILEN MOOKERJEA, Calcutta.

Liver homogenates of the rats on a riboflavin deficient regimen show increased alanine-glutamic and aspartic-glutamic transaminase activity, the rise being more pronounced in the former. When the dietary protein level is increased to 40%, the changes of transaminase activity seem to fall off.

During a stage of dietary protein depletion the liver transaminase activities decrease both in control and riboflavin deficient animals, but on a subsequent stage of protein repletion the ratio of liver weight and its nitrogen content to body weight, liver transaminases and catalase activity seem to increase significantly in riboflavin deprived animals compared to their controls.

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32. The Conversion of C^{14} Labeled Glucose Cycloacetoacetate to l-Ascorbic Acid in Germinating *Phaseolus Radiatus*.

M. L. BELKHODE and M. C. NATH, Nagpur.

A comparative study was made by imbibing uniformly labeled glucose and labeled glucose cycloacetoacetate (with glucose moiety uniformly labeled) to *phaseolus radiatus*. The yields of ascorbic acid in terms of C^{14} from glucose cycloacetoacetate was four times greater than obtained with glucose.

The experiments conducted with Glucose-1-C^{14} Cycloacetoacetate resulted in ascorbic acid formation with 68-73 per cent of activity occurring in C-1 and 14-18 per cent in C-6.

Ascorbic acid from Glucose-6 C^{14} Cycloacetoacetate labeled seeds contained 13-18 per cent activity in C-1 and 64-69 per cent in C-6. The experiments suggest that in *Phaseolus radiatus* asymmetrically labeled glucose moiety of glucose cycloacetoacetate is converted to ascorbic acid with intact carbon chain and without its inversion.

33. Studies on Pulse Protein: Part VII Influence of some Anabolic Steroid Hormones on the Utilization of Bengal gram Protein in Rats.

T. S. DE and G. C. ESH, Calcutta.

Hormones are known to play a great role in the metabolism of dietary proteins. Although their effects are not identical it is likely that the nature of proteins significantly influences their formation and function. The part played by the well-known anabolic hormone, testosterone has been followed in rats maintained on pulse protein diet in relation to their growth, protein efficiency ratio and N retention. Similar studies have also been made with synthetic steroid hormones with a view to finding out their possible importance under conditions of feeding restricted protein diets. The results tend to indicate that both the natural and synthetic hormones significantly effect the metabolism of pulse protein to the best advantage of the subjects.

34. The role of Adrenal Cortical Hormones in Allergy : Part IV —*In Vitro* Release of Histamine from Rat skin after Dextran.

B. N. CHOWDHURI, Calcutta.

Rat skin suspended in oxygenated tyrode solution at 37°C was found to release some histamine in solution. When dextran solution was added to the above solution there was further release of histamine from the rat skin. The histamine was determined biologically on cat blood pressure (carotid) and atropinised guineapig ileum. The release from skin of normal rats was found to be 9·3 μg (average) histamine base per gram of skin; when dextran solution was added, there was further release of histamine to the extent of 8·8 μg (average) histamine base per gram over initial i.e. a total of 18·1 μg (average) per gram. After injection of cortisone acetate 7 mg/100 g. daily for 7 days, the release of histamine was 7·4 μg and 0·92 μg histamine base per gram, before and after addition of dextran i.e. a total 8·32 μg per gram.

In adrenalectomised animals these figures were 9·0 μg and 27·16 μg before and after addition of dextran in non-injected animals i.e. a total of 36·16 μg per gram; in animals injected with cortisone these figures were 6·5 μg, 9·24 μg and 15·74 μg (total) histamine base per gram.

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The above observations indicate that amount of releasable histamine in rat skin is reduced after injection of cortisone acetate in both normal and adrenalectomised rats. Addition of dextran has practically no effect on further release of histamine and the animals appear to have been protected from the action of dextran in respect of histamine release.

35. The role of Adrenal Cortical Hormones in Allergy: Part III--Skin Histamine Content of Rat.

B. N. CHOWDHURI, Calcutta.

Skin histamine content of rats was determined before and after adrenalectomy. The effect of injections of glucocorticoids for a few days on skin histamine content was also studied. Histamine after extraction was determined by the biological methods on cat blood pressure (carotid) and on atropinised guineapig ileum. The skin (abdominal) histamine content of rats was found to be 27·3 μg (average) histamine base per gram of skin. When the animals were injected with cortisone 7 mg/100 g. daily for 7 days, the histamine content was found to be reduced to 9·07 μg (average) histamine base per gram. In case of adrenalectomised animals these figures were 72·7 μg and 39·4 μg histamine base per gram of skin for non-injected and injected (cortisone acetate for 7 days) animals respectively.

From the above observations, it is evident that after adrenalectomy, there is increase in histamine content of skin of rats and that both in normal and adrenalectomised rats injection of cortisone acetate for a few days produced reduction of skin histamine content in each case.

36. The Metabolic effect of sex Hormones in Dogs.

M. L. GUPTA and V. B. MATHUR, Jaipur.

The effect of administering 3 sex hormones viz., testosterone, oestrogen and progesterone on body weight and total body water content was studied in adult dogs of both sexes. Observations were made with 2 different levels of the hormones. Increase in body weight along with increase in body water content was observed in all the experimental groups. With testosterone the increases were found to be more with higher doses of the hormone. The body weight increase was however found to be less than the total body water rise indicating thereby a possible reduction in solid mass. With oestrogen, the increases were more marked in females where increase in body weight was greater than increase of body water content. But in males the effect was however like that of testosterone. With progesterone the increases were, on the other hand, slightly more in males—where higher doses also imparted more increases. Increase in body weight was observed to be more than the increase in body water content in males but with females the case was reverse. The observations thus tend to indicate the possible catabolic effect of testosterone in both sexes; of oestrogen in males and of progesterone in females; and the anabolic effect of oestrogen in females and progesterone in male dogs.

37. The effects of sex Hormones on body fluid Compartments.

M. L. GUPTA and V. B. MATHUR, Jaipur.

The effects of 3 sex hormones, viz., testostersne, estrogen and progesterone on various fluid compartments were studied in adult dogs maintained on standard diet. All these hormones were tried at two dicerent levels. The total body water

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content as well as the extra and intracellular fluid showed rise in the testosterone and estrogen administered animals. With both these hormones again the rise was observed to be more with but not proportionate to dosage increment. With testosterone the increases seemed to be mainly due to rise in extracellular fluid and R.B.C. volume and the effect was better observed in males. With estrogen dimunition in haematocrit values was noticed and all its effects seemed to be independent of sex differences. With progesterone the effects were less marked and less constant.

ANIMAL NUTRITION

38. Oxygen Consumption in Buffalo Calves.

M. V. N. RAO and D. N. MULLICK, Izatnagar.

12 Murrah buffalo calves of one to six months old were used for recording the oxygen consumption rate with the help of a Benedict Roth metabolism apparatus. A suitable face mask was used.

The oxygen consumption rate per minute increased with increase in body weight. Per unit body weight, the calculated consumption rate decreased with the increase in weight. The correlation coefficient between body weight and oxygen consumption rate per minute was found to be prositive and highly significant.

A regression equation was calculated between the body weight in kilogramms and oxygen consumption rate in calories per minute and a stright-line relation was existed. Under field conditions, this method can be used to measure the cloric requirement from the known body weight.

39. Oxygen Consumption in Hariana Calves.

M. V. N. RAO and D. N. MULLICK, Izatnagar.

Oxygen consumption was estimated in young calves with the relp of Benedict Roth metabolism apparatus.

The consumption maintained a significant positive correlation with the increase in the body weight but when calculated per unit body weight, an inverse order was followed.

A straight line relationship was found according to regression equation between the oxygen consumption and the body weight. The differences between the calculated and the observed values were insignificant.

Under field condition, the oxygen consumption or caloric requirement of calves can be estimated from the known body weight with the help of this equation.

40. Studies on the Feeding of *Lantala* Silage.

O. N. AGARWALA, S. S. NEGI and V. MAHADEVAN, Izatnagar.

Cases of livestock poisoning on *lantana camara* are well known. Due to its abundant availability in many areas particularly during scarcity periods, it was suggested if the plant could be utilised as a normal feed after processing, *viz.*, ensilage.

Two adult Kumauni bullocks fed on *lantana* silage showed clinical symptoms of *lantana* poisoning and the post-feeding blood picture of the animals for haematological and biochemical constituents was comparable to that of photosensitised animals.

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41. Effects of Supplementing Milk Diet with Magnesium on the growth, Blood Composition and Endocrine Weights in Rats.

RENUKA MISRA, BIMLA KAKKER and D. N. MULLICK, Izatnagar.

Two groups of 12 young rats were fed only cow and buffalo milk. 3, 6 and 9 mg. of magnesium in solution were fed daily. Weekly body weights were recorded for 11 weeks, after which the animals were sacrificed. The blood and serum of individual animal were analysed for haemoglobin, calcium, magnesium and cholesterol and thyroid and adrenals were weighed. Results indicated that the supplemented groups on cow milk diet showed improvement in the growth rate but lowering in the serum calcium and cholesterol. The weight of the endocrines registered a negative relation with the increase in the dose of supplementation.

The buffalo milk contains higher amounts of some nutrients which cause the significant increase in the growth rate in comparison to the groups on cow milk. The addition of magnesium failed to show much difference from the control in all the constituents analysed. It may be presumed that the supplemented level of magnesium is not sufficient to show any effect in presence of higher level of fat.

42. Effect of Copper and Cobalt Supplementation on the Blood Constituents in Young Growing Hariana Calves.

P. K. DWARK NATH, V. S. BISARIA and V. MAHADEVAN, Izatnagar.

In an endeavour to assess the effect of copper and copper with coblat supplementation on the health of the young ruminants an experiment was designed with 10 Hariana calves over a period of one year. The calves were given basal ration supplemented with copper and cobalt in varying levels.

Periodical bleeding once in a month was carried out and the blood constituents were estimated. The copper content in the whole blood of the groups fed copper and copper supplemented with cobalt remained higher; the Cu with cobalt supplementation, however, helped to maintain the blood copper level to the maximum.

The haemoglobin levels as well as the erythrocytic counts of copper with cobalt group were also found highest.

The leucocytic counts were, however lower, in the copper with cobalt fed group.

Serum calcium and inorganic phosphorus in blood did not reveal any significant alteration in experimental groups.

The cobalt and copper supplementation thus seem to be helpful in calf feeding even if rations are not deficient in copper or cobalt.

43. Studies on the Metabolizable and Productive Energy of Poultry Rations.

H. R. SHARMA, P. V. RAO, R. MUKHERJEE and S. BOSE, Izatnagar.

The present investigation was carried out with a view to compare the reproducibility of the Metabolizable energy (M.E.) and Production energy (P.E.) values of poultry feeds. For this purpose, two experiments were conducted on growing R.I.R. chicks using two rations of which only one contained animal protein. The M.E. and P.E. values were determined on chicks at 0-8 weeks of age. In each experiment, the birds were randomly grouped into two batches and the chosen ration was fed *ad lib.*

The M.E. values at two-weekly intervals in the two experiments ranged from 2·17 to 2·42 K. cals/g. of diet on dry matter basis and indicated a constancy at various stages of growth and reproducibility in duplicate experiments. On the

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other hand, the P.E. values of the rations at different stages of growth ranged from 0·84—1·17 K. cals/g. of dietary dry matter. For the same ration there was a wide variation in the P.E. values at the different stages of growth and the reproducibility of the values in duplicate experiments was poor. It is concluded that in comparison with P.E., the M.E. is a better measure of the energy value, by dint of easier estimation and better reproducibility.

44. Studies on the Toxicity and Nutritive Value of Fungus-Free *Paspalum Scrobiculatum* grains.

O. N. AGARWALA, S. S. NEGI and V. MAHADEVAN, Izatnagar.

Paspalum scrobiculatum (*kodo*) grains were raised from a toxic variety of seeds. The grains produced were found to be free from fungus and when fed to albino rats over a prolonged period did not produce any symptoms of poisoning.

The nutritive value of fungus free grains of *Paspalum scrobiculatum* has been evaluated by replacement by *kodo* seeds of 0,25,50 and 75 per cent of the combined basal moiety consisting of 70 parts maize flour, 25 parts gram flour and 3 parts wheat bran in the adequately supplemented stock diet of rats. The growing albino rats when placed on the different diets for a period of ten weeks were found to fair equally well. The average digestibility of crude protein and the average nitrogen, calcium and phosphorus balances of rats on the experimental diets were quite satisfactory.

It appeared that P. *scrobiculatum* grains produced under normal conditions may be profitably utilized as a normal ingredient of the diet of laboratory rats or other animals in place of cereal or millet grains.

45. Effect of Supplementation of Poultry Ration with "Brewer's Dried Yeast."

H. P. TANDON, G. V. RAO and S. BOSE, Izatnagar.

Studies have been made to find out the effect of supplementing the poultry ration, consisting of yellow maize, barley, wheat bran, groundnut cake, fish meal, calcium grit, bone meal and shark liver oil with dried Brewer's yeast at 2% level. The feeding trial was carried out on 70 chickens of R.I.R. breed from 8 weeks to 9 months of age.

The supplementation of the ration with yeast enhanced growth by 29·9% up-to 12 weeks of age indicating that it is very beneficial for broiler production. After the 12th week the increase in growth declined to 10·7%, 5·5% and 3·1% at 16, 20, and 24 weeks of age respectively.

Addition of yeast to the ration hastened sexual maturity by about 38 days in the pullets and increased average egg production up to 9 months by 15%. Average egg weight was however less by 2·17 drachms.

46. Provision of Artificial Light to Grown up Immature Pullets.

H. P. TANDON, G. V. RAO and S. BOSE, Izatnagar.

Studies have been undertaken to find out the effects of provision of artificial light to grown up Rhode Island Red pullets that did not commence laying till the end of October. The durations of exposure to artificial light were whole night and 2 and 3 hours in the morning and 2 and 3 hours in the evening both in continuation of day light. The experiment was commenced on 1st November and continued till the end of February.

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The results of this experiment revealed that provision of artificial light to grown up pullets of R.I.R. breed during winter months brought about the following effects :

1. It hastened maturity by 9 to 17 days and that the stimulation in this respect was proportional to the extent of exposure up to 3 hours duraion. The whole night exposure brought about practically the same results as the 3 hours exposure.
2. It increased egg production during the exposure period by 5 to 8 per cent.
3. The morning and evening lights increased production during the 1st month of the commencement of the exposure followed by a little decline during the next 2 months and then again an increase in the 4th month of treatment.
4. The stimulation in respect of egg production brought about by whole night light exposure decreased as the period of exposure advanced.
5. There was excessive mortality in the whole night exposure group.
6. The exposure to artificial light, its time and duration did not materially affect the fertility and hatchability of the eggs laid by the exposed pullets.
7. Provision of light increased food consumption by about 5 to 9 grams per bird per day.

47. Studies on Blood of Growing Calves on Different Levels of urea Ingestion.

P. C. SAWHNEY, S. C. BISARYA and S. C. GUPTA, Izatnagar.

In order to study the influence of feeding urea on the blood composition of *Hariana* male calves, studies were conducted with 40 and 50% of digestable dietary protein replaced by urea. The feeding period was for 52 days. During mid-experimental period no appreciable change was noticed in normal blood constituents, whereas in post-experimental period analysis revealed slight increase in inorganic phosphorous, and appreciable increase in urea, urea N and N.P.N. contents of the blood on both the levels of urea supplementations. Increase of urea supplementation from 40 to 50% however, revealed no alteration in the blood constituents.

48. Preliminary Studies on the Effect of Aurofac Feed Supplement on chicks fed a Typical Indian Village Ration, with Special Reference to Vitamin A Storage in the Liver.

P. G. PANDE, K. K. PAL, R. MUKHERJEE, P. V. RAO and S. BOSE, Izatnagar.

Antibiotic feed supplements are extensively used in the rations of chicks as growth stimulants. In order to determine the effect of Aurofac (a by product in Aureomycin manufacture) feed supplement on chicks fed typical Indian village ration with special reference to vitamin A storage in livers, day-old chicks were reared on typical village rations supplemented with Aurofac and vitamin A with/without Lucerne meal. The average weekly food consumption was much lower when the feed was not supplemented with Aurofac and Lucerne. The average growth rate increased with supplementation. Lucerne supplementation favoured higher rate than Aurofac supplementation. Aurofac with Lucerne, however, imparted maximum growth rate. Mortality study revealed decrease in mortality with Lucerne and Lucerne with Aurofac supplemented diets. Least mortality was observed with Lucerne supplementation only. Carotene content in the liver and blood in all groups of birds was inappreciable and liver storage of vitamin A was very low in all the experimental groups.

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49. Quantitative Feeding of Philosamia Ricini Hutt Larvae.

R. P. KAPIL, Ranchi.

The feeding experiments on the larvae of *P. ricini* were based upon the principle of continuous and discontinuous feeeding. The larvae were fed at varying intervals of 4-hr., 6-hr., 8-hr. and continuously. In the main the idea was to select suitable feeding schedule, based upon time interval and quantity of the castor leaves to be served at a time, to see the possibility of its economic feeding to Eri-silkworms.

The experiments were conducted during February/March when the average room temperature and humidity were 20·8 C and 45·22% (R.H.) respectively. The larvae having yellow colour were drawn from experiments on segregation and experimental hybridation. The stock had shown 64% purity in the previous generation and absolute in the current.

It was observed that in the 1st. intermoult 3 feeds and in the 2nd. to 4th. intermoults feeding at 4-hr. interval are sufficient. In the 5th. intermoult, it may be increased gradually by 2 or 3 feeds per day at the most, particularly from 3rd. to the 8th. day. Periodic starvation of the Eri-silkworm larvae lengthens the 5th. intermoult. Mortality is directly proportional to the feeding periods. It is most in the 5th. intermoult. The mortality of the larvae for mounting is postponed by 2-days if each feed is delayed by 2-hr. Further delay of 2-hr. of feeding period has a cumulative increase in maturity period of 3-days. Actual process of cocoon formation is not apparently effected except some adverse tendency in 8-hr. lot.

HISTOLOGY AND HISTOCHEMISTRY

50. Histological Changes in the Nerve Cells of Rats after Picrotoxin Administration.

(Miss) KRISHNA SIKDAR and J. J. GHOSH, Calcutta.

Attempts have been made to correlate the histological and histochemical changes in nerve cells of rats after picrotoxin administration, with other biochemical changes that are being started in this connection. Different regions of brain tissues were sectioned and stained with methylene blue, thionin and gallocyanin stains. Areas of nucleus and nucleolar portions of individual neurone cells were traced out by camera lucida and measured by planimetry. Measurements were mostly taken of neurone cells of normal and pictrotoxin-treated animals in the pons and medullary regions.

Preliminary determinations of nucleus and nucleolar areas reveal that both in the pons and in medulla, the nucleolar areas are significantly increased after picrotoxin administration, the areas of the nuclei are also increased but the increases are not so well-marked as in the cases of nucleoli. The nature of staining of Nissl substances, under identical conditions studied, reveals that the Nissl bodies undergo partial chromatolysis because of their faint staining and granular in appearances.

51. Aortic Changes in Cholesterol-fed Chicks and Pyridoxine-Deficient Rats.

MADHUSADAN GHOSAL and D. P. SADHU, Calcutta.

A study on the changes in the elastic components of the aorta with a view to the determination of its possible role in atherogenesis in hypercholesterolaemic conditions have been made. It has been observed that in pyridoxine-deficient rats

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and cholesterol-fed chicks splitting up and general fraying of elastic tissue in aortae begin to take place much before any significantly discernible sudanophilia of aortic intima. This is accompanied by decreased plasmal reaction and decreased unsaturated fatty acids in the thin film of lipids adhering to the surface of the elastic fibres, decreased phospholipids, increased calcium deposition in aortic intima and increased metachromasia. Colesterol deposition begins to set in after more prolonged experimental condition. It is concluded that the change in the patterns of elastic behaviour may play some role in bringing about the lipid deposition in the experimental animals.

52. Changes in the Cytoplasmic Constituents of Liver after Carbon Tetrachloride Intoxication.—A Histochemical Study.

B. CHAKRAVARTY and C. DEB, Calcutta.

An extensive fatty degeneration in liver has been observed after carbon tetrachloride poisoning in rats. In the present investigation, changes in the different histochemically demonstrable cytoplasmic constituents under such condition have been studied.

A disturbed carbohydrate metabolism has been observed after intraperitoneal injection of carbon tetrachloride. This is concluded from the observation of high fasting blood sugar and reduced glycogen content of liver. Along with this there was a fall in both succinic dehydrogenase and glucose-6-phosphatase. No abnormality was however been observed in the Islets of Langerhans of pancreas. External injection of insulin caused a fall in blood sugar level like normal animals. It has been suggested previously that the high neutral lipid observed in the liver is formed from carbohydrate. Rise in plasmalogen observed in the liver of treated rats was due to this conversion of carbohydrate to fat. An inverse relationship as regards the distribution of different enzymes has been noted in the damaged liver. Hepatic area containing very high neutral lipid was practically devoid of any enzymatic activity. In the region of undamaged cells higher amounts of acid and alkaline phosphatase were however present. This unaffected portion also showed higher amount of α-amino acids and R.N.A.; but not the fatty region. There was a rise in D.N.A. content in the intoxicated liver.

53. Succinic Dehydrogenase and Esterase Distribution in Toad (Bufo Melanostictus).

MRITYUNJOY MUKHERJI and CHANDICHARAN DEB, Calcutta.

Succinic dehydrogenase and esterase have been studied histochemically in different tissues of toad in hibernation and non-hibernation.

Very high amount of succinic dehydrogenase was observed in the liver of toad during April. During August, succinic dehydrogenase content of liver was found to be low, which declined further during pre-hibernation and the hibernation periods. The esterase content of liver was found to remain almost unchanged throughout the year. Very little decline in succinic dehydrogenase contents of heart and muscle was observed during hibernation. Decline in intestinal succinic dehydrogenase has been related to the decline in intestinal activity during hibernation. No change in the esterase content of the intestine was observed. A small decline of both the enzymes in kidney as observed during hibernation is probably due to little alteration in kidney function during hibernation. Non-secretory accumulation of esterase in the acinar cells of pancreas has been observed during hibernation.

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The possible relationship of the levels of dehydrogenase activity in various tissues during hibernation and non-hibernation with carbohydrate metabolism has been discussed.

PHARMACOLOGY

54. Action of Chaksine Chloride on Respiratory and Cardiovascular System.

M. L. CHATTERJEE and C. D. DEY, Calcutta.

Chaksine is an alkaloid isolated from the seeds of *Cassia absus*.

Chaksine chloride has been observed to stimulate respiration with lower doses and to depress with higher dose. However, the tolerance varies in different species of animals. The drug exerts its action at least partially influencing the respiratory centre proper. The alkaloid produces a sustained fall of blood pressure in anaesthatised animals which remains unaffected after vagotomy, atropinisation or in decerebrate preparation, but the fall is reduced in spinal animal indicating a central site of action. The hypotensive effect is also reduced partly after pendiomide and the rest of the fall can be blocked by heavy dose of anti-histaminics. Moreover, the drug shows anti-nicotinic actions on B.P. and isolated heart and peripheral ganglian blocking actions.

Thus the mechanism of fall of blood pressure by the drug appears to be a complex one. Partly it is due to ganglian blocking action and partly due to histamine like effect.

55. Effect of a few Compounds on Blood Sugar Level and Catecholamine Content of Adrenal Glands of Cats.

M. L. CHATTERJEE and M. S. DE, Calcutta.

An anti-histaminic agent promethazine, a tranquilizer trifluprομazine, an adrenolytic agent dihydroergotamine and an anti-hypertensive agent guanethidine were tested for their effects on blood sugar level and adrenal catecholamine content of anaesthetised cats. It was seen that the anti-histaminic agent promethazine, which has slight catecholamine-releasing effect produces slight fall in the blood sugar level. The tranquilizer trifluprομazine and the adrenolytic agent dihydroergotamine having no catecholamine releasing effect lower the blood sugar level to a greater degree, dihydroergotamine being most effective of the three. The antihypertensive agent guanethidine which is a sympathetic blocker, without any adrenolytic effect releases some amount of catecholamines from adrenal glands and raises the blood sugar level. These as well as our earlier observations suggest that it may be misleading to presume or predict what will be the effect of an agent on blood sugar level merely from the fact of release or not of catecholamines from adrenal glands.

56. Search for Potent Hypoglycaemic Agents, Part III. Mode of Action With Special Reference to Biguanides.

A. N. BOSE and S. P. PAUL, Calcutta.

The mode of action of the synthetic hypoglycaemic agents is yet far from clear. Biguanides studied in comparison to tolbutamide and insulin revealed that biguanides in general cause depletion of liver and muscle glycogen and increase plasma inorganic phosphorus level in fasted guineapigs, whereas insulin and

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tolbutamide exert reverse effect. To have an insight into the reason behind this anomalous effect of different hypoglycaemic agents the effects of the biguanides (Ad_2, Ad_3 and Ad_4 or benzyl, α-phenethyl, β-phenethyl biguanides respectively), tolbutamide and insulin on liver and muscle glycogen content and on plasma inorganic phosphorus level after a high glucose load were investigated.

Results indicate that amongst the biguanides, Ad_2 treated animals show a depletion of liver glycogen even when the blood glucose is normal, whereas in Ad_3 and Ad_4 treated animals, this remains practically unaltered. Muscle glycogen values show slight increase or remain unaffected with biguanides after glucose load. In insulin and tolbutamide treated groups however, both muscle and liver glycogen is found to be increased with the same load. With regard to plasma inorganic phosphorus it is significant to note that while insulin and tolbutamide cause hypophosphatemia, biguanides in general, produce a rise in plasma inorganic phosphorus which is more pronounced in Ad_2 treated groups.

57. A Study of the Action of Reserpine (Serpasil) on the Hypothalamus.

S. R. DASGUPTA and R. C. MAZUMDER, Calcutta.

Lymphocytopenia following emotional stress in normal rabbits is one of the most rapid indicator of anterior pituitary activity. This anterior pituitary activity, however, is under hypothalamic control. Any effect of reserpine on lymphocytopenia of stress, then, might also be interpreted as an action on the hypothalamous, and the present work was, therefore, undertaken.

Blood was collected in control experiments directly from rabbit's ear vein before and after subcutaneous faradic shocks. Next, after drawing the blood sample, reserpine (Serpasil) was administered; intramuscularly to the rabbit. After about an hour or so when the animal was visibly under the influence of the drug, faradic shock was given subcutaneously. Blood was again collected 3½ hours after the application of stress.

The common finding was that, 3½ hours after the stress the blood count showed (1) a rise in total W.B.C., (2) a rise in neutrophils and (3) a definite fall in lymphocytes. The significant finding, however, was, whereas in the control experiments the lymphocytopenia was only relative and not absolute, the lymphocytopenia after the administration of drug and stress was not only marked but absolute.

This showed that not only reserpine did not have any inhibitory effect on the ACTH liberation by the hypothalamus, but also that it appeared to stimulate it. The significance of these findings have been discussed.

58. Effect of Exposure to Cold on Blood Glucose Level in Men.

B. S. KAHALI and K. P. KHUTETA, Jaipur.

Effect of exposure to cold on blood glucose level has been studied in men. The subjects were exposed to cold and arterial blood level of glucose was determined. Blood glucose level showed a significant rise. The possible mechanism of this hyperglycaemia has been further investigated by simultaneous determination of blood potassium and adrenaline. All subjects showed a varying rise of blood potassium and adrenaline. Hyperglycaemia in cold stress is possibly produced by increased glycogenolysis due to the "emergency discharge of adrenaline", which occurs in all kinds of stress situations. Hyperkalaemia observed in these subjects is partly due to increased glycogenolysis in liver and other tissues and partly due to catabolic effect of glucocorticoids liberated during stress.

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59. Studies on Acute Toxicity of Glucose Cycloacetoacetate and its Hydrolysed Product.

A. K. DORLE and M. C. NATH, Nagpur.

The oral and intraperitoneal acute toxicity of Glucose Cycloacetoacetate (GCA) and the product obtained by its hydrolysis with HCl (GCA-hydrolysate) which is known to contain 1 :2 dienol glucose has been studied in mice. The oral administration of GCA and GCA-hydrolysate is found to be absolutely non-toxic. Intraperitoneal administration of GCA even to the extent of 750 mg./100 g. body wt. is non-fatal. GCA-hydrolysate in the doses up to 250 mg. equivalent/100 g. body wt. is absolutely non-toxic. LD_{50} of GCA hydrolysate is calculated to be 600 mg. equivalent/100 g. body wt.

60. Studies on Synthetic Antispasmodics: Part IV.

SRIPATI BOSE and A. N. BOSE, Calcutta.

It has already been communicated that while searching for newer antispasmodics in the β-amino ketone series, some of the compounds, i.e. (4-phenyl-4-benzylidine-1-piperidine-butan-3-one hydrochloride)—C_1; and (4-phenyl-4-benzyl-1-piperidino-butan-3-one hydrochloride)—C_2, showed some cardiac stimulation. While working to explore the degree of such activity, some newer characteristics of the compound C_2 on toad heart were noticed.

(i) The heart could be made to tolerate a much higher concentration of the drug when administered in gradual doses.

(ii) With each washing away of the drug, the heart was found to attain a stimulatory phase following an initial state of depression.

The first point is possibly due to, the heart developing a tolerance towards the compound, similar to the development of tachyphylaxis in vasomotor reaction. The second point may possibly be due to the fact observed with some other amino ketones that the drug in minute traces produces an increased contractibility of the heart muscle and a prolonged diastolic pause.

61. Safety Index of Ether, Chloroform, Trichlorethylene and Halothane in Mice, Rats and Guineapigs.

M. N. GHOSH, R. K. SRIVASTAVA and A. K. GHOSH, Kanpur.

An apparatus has been devised for testing margins of safety of volatile anaesthetics on small laboratory animals like mice, rats and guineapigs. With the help of this apparatus the individual anaesthetic dose (IAD) as well as the individual fatal dose (IFD) are measured in each animal and the "safety index" calculated as the ratio IFD/IAD. Reproducible results are obtained with only 5 animals.

A comparative study has been made with ether, chloroform, trichloro-ethylene and halothane on mice, rats and guineapigs. With exception of trichloroethylene, ether appears to be the safest of all the anaesthetics tested. Chloroform and halothane have almost equal margin of safety. In contrast to ether and chloroform, halothane gives fairly constant "safety index" in all the three species of animals tested. There is no significant difference between the "safety index" of chloroform in young and adult of mice, rats and guineapigs.

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62. Studies on mode of Action of Alkaloids Employing Lactic Acid Bacteria.

S. K. PAIN and B. N. DUTTA, Calcutta.

Administration of chemotherapeutic drugs to human patients produces undesirable side effects like vitamin deficiency and manifestations of toxic symptoms. The present study was undertaken to observe the toxic effects of alkaloids like morphine, atropine, quinine, pethidine, strychnine, caffeine, codeine, emetine and papavarine on lactic acid bacteria grown in vitamin assay media enriched with the particular vitamin to be assayed for optimum growth. *Lactobacillus casei ATCC 7469* was grown in media for folic acid and riboflavin, *Lactobacillus arabinosus 17-5*, in media for niacinamide and *Lactobacillus leichmannii ATCC 7830* in media for Vitamin B_{12}.

The maximum non-inhibitory concentration, the concentrations of the alkaloids to produce 50 per cent inhibition of the maximum growth for the organisms mentioned above were determined. Quinine, strychnine, pethidine and emetine exert maximum inhibitory effects while atropine, caffeine and codeine are practically inactive or partially inhibitory in very high concentrations. In the light of the data obtained the former group of alkaloids may be classified as inhibitory, while the others as partially inhibitory or inactive. In general, most of the drugs are relatively more toxic for *L. leichmannii* than for *L. arabinosus* and *L. casei*. Aside from the possible practical application of these findings in nutrition, however, such drug-vitamin studies may help elucidate the mechanism of action of alkaloids in biological systems.

63. Study of some Heterocyclic Compounds for Anti-Helminthic Action.

J. K. MOHANTY and B. N. DAS, Burla.

Fourteen heterocyclic compounds which are either rhodanins or benzothiazoles were studied *in vitro* for possible anti-helminthic property by using preparations of *Ascaris lumbricoides* and *Pheretima posthuma*. Out of these only two compounds exhibited significant anti-helminthic activity under the experimental conditions. Chemically both the active compounds are benzothiazole derivatives. The results of this investigation most probably warrant further study of the two active compounds and screening of newer benzothiazole derivatives for anti-helminthic action.

64. Anti-Bacterial Activity of some Thiazole Derivatives.

J. K. MOHANTY and B. N. DAS, Burla.

Sixteen newly synthesized heterocyclic compounds were studied for possible anti-bacterial activity. Initial screening tests were carried out by modified hole-plate method using *Micrococcus pyogenes var. aureus* as the test organism. Compounds, which by this method were found to exhibit significant anti-bacterial activity, were further tested by serial dilution method for quantitative estimation of their potency. Only four compounds of this series were found to have bacteriostatic property. Study of structure-activity relationship of the compounds of this series reveals that all four compounds found active belong to the group 2-amino-5-sulphonamide-thiazole. As such the compounds of this group are thiazole analogues of (p)-amino-benzene-sulphonamide. Of the four active compounds M-99-BB (code number) was the most potent. Examination of its structure shows that it is isosteric with (p)-amino-benzene-sulphonamide. The effect of various radicals when introduced in position-4 of the thiazole ring on anti-bacterial activity has been discussed.

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MISCELLANEOUS

65. Separation of Amino Acids by Asbestos Chromatography.

B. N. SEN and N. B. CHATTERJEE, Burdwan.

The technique of the asbestos chromatography originally developed for the estimation of inorganic ions in mixtures has been extended here to the separation of the few amino acids. The separation of the mixture seems to be quite effective and reproducible. The whole method is comparatively simple and less time-consuming.

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SECTION OF PSYCHOLOGY AND EDUCATIONAL SCIENCES

President :—Dr. G. D. Boaz, M.A., D.Phil. (Oxon.)

Abstracts

GENERAL

1. The Role of Psychologists in the National Development of India.

S. V. KALE, Bombay.

With limited resources at our disposal and vast strides yet to be taken, India has no other alternative but to adopt a system of planned national development. If the allotments in the third Five Year Plan are scrutinised, one finds about 24% outlay for what may be termed expenditure on *'psychological sector'* which comprises education, social and labour welfare, community development, health, housing, rehabilitation etc. A detailed inventory is made in this paper of the different "ad hoc" opportunities of national service as well as professional and personal advancement that exist for psychologists in the present set-up of the execution of the Third Five Year Plan. However, these opportunities have not been properly transformed into clearly perceived and accepted 'roles' of psychologists in national and social development. The psychologist may have to hold himself responsible for this situation, because maximum use of the independent recognition that psychology won as a science in India some three or four decades ago has not been made. Even now, the psychologist is in a position to recover the lost ground by making contributions towards the scientific understanding of the various barriers in our national development. Problems like individual's general attitude to life and work, in India, or communal, regional and language factors in national integration await research-oriented answers. The psychologists also owe it to the nation to try for a nation-wide acceptance of testing procedures, at various educational levels, and for a nation-wide use of the results of test-data for the assessment of qualified human potential in various professions. The role of psychologists, far from being a static conception, needs continuous evaluation.

2. Right approach to emotional integration.

K. K. PANIKAR, Poona.

How to bring about emotional integration on a national level poses to be a difficult problem for the political leaders of the present—Emotional Integration Committee appointed by Government of India under Ministry of Education is in evidence for the same—general feeling that emotional disintegration was not evident—at least as evident as at present—before Independence—need—proper understanding of the expression—'emotional integration'—'emotional integration' as integration of right type of feelings about situations in life with a strong reaction to act rightly upon them. Levels of emotional integration : (1) Home, (2) School including University and (3) National.

The process of emotional integration—influence of the working natural social tendencies viz., imitation, suggestion and sympathy. Their influence at home, school and society. The main factors that are causing this disintegration—emotional integration or disintegration has a tendency to flow from the elders to the young. How far are the parents and the teachers responsible for this integration—

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What is the place of the politicians in the process of this disintegration—Right beginning from the top above—Education dominated by politics—Education of politicians by politicians will be the right approach—When can teachers properly help this integration? After they are free from economic and political domination.

3. What is Vedic Culture?

K. A. PATWARDHAN, Indore.

The paper starts by explaining that the Vedic or Bharateeya culture has been created by the inhabitants of Bharatvarsha, who are the followers of the path of light or knowledge determined, shown and prescribed by the Vedas. Later on an attempt has been made to show that the Vedic Mantras or Aphorisms covered practically all the branches of knowledge of mind and matter in its perfect and unalterable form and taking full advantage of their knowledge of the Universe and of the evolution of the human body as the final product of organic evolution, the Vedic sages established the theory that the body of a living human being is an Universe in miniature while the Universe could be said to be a highly magnified human body. On the basis of this theory the new social structure which the Vedic Savants created, was so framed that it was a man made replica of a human body and hence also of the Universe. Such a social order, which promoted cultural creation, being based on perfectly scientific footing, gave birth to the civilization known to be existing in the world as Vedic 'Sanskriti' or Vedic Culture.

EXPERIMENTAL PSYCHOLOGY

4. Experimental Study of Individual Preferences for Two Colour and Three Colour Designs.

K. N. SHARMA, Calcutta.

The problem of differences in individual preferences is attracting the attention of psychologists more and more. The present investigation was undertaken as an attempt to study one aspect of individual preferences, *i.e.*, to study the factors responsible for the difference in the preferences for colour-combinations. For the experimental and analytical procedure the multidimensional method of successive intervals was employed. As a result of factor analysis, three factors were extracted which seem to affect the individual preferences. The factors have been interpreted as : (1) Number of colours used in the combinations, (2) Principle of Proximity; and (3) Principle of Closure.

5. Study of Colour Preferences in Subjects Ranging from 4 to 45 Years Age.

P. KRISHNAMURTHY and P. NATRAJ, Mysore.

A number of studies on colour preferences were carried out by Western Psychologists on whites as well as other races to investigate the effects of culture, age, sex and education on colour preference.

The present investigation on a section of Indian population was undertaken to study primarily the influence of age and to provide comparative norms.

Six major colours Red, Green, Blue, Yellow, Orange and Violet were used to study the preferences in 1255 female subjects ranging in age from 4 to 45 years drawn from Mysore city. The rank ordered data from each age group was transformed into scale values following Guilford's composite standard method,

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The general trend is that Blue, Green and Red are preferred most while Yellow and Violet are least preferred.

Neither any marked group tendency in each age group, nor any orderly shifts in colour preference with progress in age is evidenced.

At the lower age ranges, the differential preference for colours is low; and with age the differential preference increases.

The final rank order of colours, ignoring the age, resembles closely the rank orders for colours given by whites.

6. The influence of meaningfulness of stimulus and response members in Paired Associate Learning.

V. K. KOTHURKAR, Poona.

This is a report of an experiment in which an attempt has been made to investigate the relative influence of the meaningfulness of the stimulus and response members in paired associate learning. The following experiment was based on the hypothesis that meaningfulness of the response member has greater facilitative effect on paired associate learning.

METHOD

Four paired associate lists each consisting of 10 pairs drawn from Nobles' (1952) list of dissyllabic nouns and paralogs calibrated for meaning (m), constituted the materials of this experiment. High-High, Low-High, High-Low and Low-Low lists were constructed by appropriate combinations of the scaled dissyllables and paralogs.

Not only the acquisition but also the retention aspect of learning was investigated in this experiment. Generally, in exploring difficulty—meaning relationship experiments are designed with attention to mere acquisition of verbal materials. Instead of assuming that similar relationships would obtain in retention as well, an attempt was made to study the aspect of retention experimentally.

RESULTS

(*a*) *Learning* :—The mean learning scores for the four principal experimental groups were 10·85, 12·55, 14·13 and 33·70 for High-High, Low-High, High-Low and Low-Low lists respectively. The results clearly show—an increasing rank order of difficulty for the HH, LH, HL and LL lists. Of the two experimental conditions, Low-High and High-Low, the one with high meaningfulness of response is easier—and the other with low meaningfulness of response member is more difficult.

(*b*) *Retention* :—The mean recall scores (number of items recalled) of the four experimental groups were : 8·98 (Low-High); 7·95 (High-High); 7·48 (High-Low) and 6·99 (Low-Low). It is important to note that in respect of retention (recall) the experimental condition Low-High scores an advantage not only over its reverse condition High-Low but also over the condition (High-High).

Statistical Analysis of Variance and tests of statistical significance are given. Results and discussion bear out the original hypothesis.

7. Influence of controlled time gap on estimation of duration.

R. G. CHATTERJEA and G. B. SAHA, Calcutta.

An attempt is made in this paper to show that in a controlled time gap (T.G.) the trend of the estimation would be different from the one's where T.G. was uncontrolled. The estimation in this case would then be all over-estimates,

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Three sets of data were obtained—where set I and set II were in ascending and descending orders of presentation respectively. The time gap in this case was the same as the stimulus times. In set III the presentation of stimulus times was haphazard and the T.G. was controlled by the experimentor. In that the observers were required to sit quietly for a considerable amount of time to hear the signal.

In the result it was found that all the stimulus times were over-estimated in three experimental sets. The trends of the estimations showed a regular rise along with the rise in the stimulus times but the constant error (C.E.) values were great.

8. Depth Perceptions: I. Practice-effect and II. Effect of rod-width on distance discrimination.

ARUN K. SIRKAR, Calcutta.

The present work, a part of the proposed intensive study on distance discrimination, has been designed to note the practice-effect and the change in the judgments with the variation of rod-width in a modified Howard-Dolman apparatus. The results indicate a small change due to practice, though statistically insignificant and reveal some unusual phenomena contrary to the past researchers' contentions in regard to the effectivity of the changing rod-width.

9. Two-choice learning in children and adolescents under rewarded and non-rewarded conditions.

J. P. DAS and K. C. PANDA, Cuttack.

This study investigated the effects of age differences as well as the presence or absence of a material reward on two-choice learning where E_1 and E_2 had probabilities of ·75 and ·25 respectively. An equal number of children and adolescents were divided into 8 groups of 17 *S*s each, corresponding to the 8 experimental levels. The other variable was picture and non-picture stimulus cards. Learning was quick and at the end of 100 trials, reached a level higher than the usual 75 per cent asymptotic level. Reward seemed to affect learning adversely in the initial stages, but was responsible for a steeper learning curve as indicated by a significant *F* for trend. Children predicted E_1 oftener than adolescents in the earlier trials. Likewise, pictures were predicted more often than non-pictures in the initial trials. It was suggested that reinforcement would act as a distractor if it can convey adequate information about the learning task.

10. Nature of the error ratio curve in a psychophysical experiment.

AMAL KUMAR MALLICK, Calcutta.

The error ratio is defined as the ratio of the differences between the subjective judgment of a stimulus in the fractionation method and the judgment expected, to the expected judgment. Error ratio values obtained in a psychophysical experiment on half-angle judgment for angles between 1° to 359° are plotted against the expected judgment values. The statistical curve roughly conform to the mathematical curve represented by the equation, $y = -ae^{--bx}\sin 3x$. The periodicity is not strictly speaking regular, as in the mathematical curve, the amplitude ae^{-bx} decreases with the increase of x.

A detailed study of the curve is in progress.

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11. Influence of colour on weight-judgment.

AMARENDRA NATH BANERJEA, Calcutta.

The investigation was aimed at determining the influence of colour, if any, on the comparative judgments of weights for a given series of objects.

Wooden cubes of identical sizes and weights (physical) but of different colours, were used as materials for the study. Twenty high-school pupils (ten boys and ten girls) of the age range 14 to 16, and having normal visions (chromatic and achromatic) comprised the group of subjects.

In the experiment (conducted individually) the subjects were asked to assign relative weights for each of the cubes presented as (i) a series of six colours (four chromatic and two achromatic) and (ii) a series of four primary colours (chromatic). The conditions of presentation (for each series) enabled the subjects to form their judgments by (a) visual, (b) visuo-tactual and (c) tactual (having tied eyes) perceptions of the objects—thus permitting the colours to influence judgments in the first two presentations only.

The resulting data, when analysed, suggested the following conclusions :

(1) Weights assigned to different objects were definitely influenced by their specific colours.

(2) In the series of six colours, the black gave the impression of the heaviest and the white the lightest.

(3) In the series of four primary colours, the corresponding impressions shifted respectively to the blue and the yellow.

(4) Tendency to associate weight with colour was found to be independent of the sex-differences.

12. Complexity—Simplicity dimension and the perceptual preference pattern of the Musician and Non-Musician: A Comparative study.

MANAS RAYCHAUDHURI, Calcutta.

The capacity to tolerate ambiguity and a tendency to prefer complex stimulus material in the perceptual field have long been recognised as possible variables in the personality of the artists. Eysenck also suggested of a bipolar factor of 'simplicity—complexity' for polygon preferences. Recently a systematic and objective method of measuring these variables have been suggested by Barron and Welsh, who have constructed a figure preference test (WFPT) consisting of a set of black and white figures that significantly differentiate Artists from Non-Artists in terms of their preference dichotomy. The stimulus figures of the test, underlying 'complexity—simplicity' dimension, range from simple geometric forms to complex and diverse patterns and designs. Raychaudhuri in an earlier paper has reported that the Art scale of WFPT could be used successfully in differentiating Artists from Non-Artists in Indian population.

The purpose of the present research is to see whether Musicians who work in a different medium and with different tool from the painting-Artists do equally well in Art scale of the WFPT. The two hypotheses tested are :

(*i*) that the musicians differ significantly in their Art scale scores from the scores of the non-artists, non-musicians and

(*ii*) that the musicians do not differ significantly in their scores from that of the scores of the painting artists.

The Barron-Welsh Revised Art scale (RA) is applied to three groups—(i) Experimental Group consisting of 30 professional musicians, (ii) control group I consisting of 50 individuals engaged in Non-musical, non-artistic professions and (iii) control Group II consisting of 60 senior stu-

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dents of fine Arts-painting. The mean scores of the Musician and Non-Musician group are 29·00 and 19·90 respectively. This mean difference gives a 't' of 4·57 which is significant at ·01 level of confidence.

The mean scores of the Musician and Fine Art-Painting group are 29·00 and 40·83 respectively. This mean difference gives a 't' of 5·28 which is significant at ·01 level of confidence. If we do not disregard this difference as due to sampling errors we may assume that painting artists professionally develop a greater capacity to tolerate complex visual stimulus material than the musicians. Musicians though possess greater capacities than the non-artists in this dimension do not develop it to the extent as the painting-artists do, which may be due to the musicians' concentration in auditory sense-area.

TESTING AND MEASUREMENT

13. A comparative study of 'Intelligence Scores' by *Rural* and *Urban* school children.

S. JALOTA, Punjab.

There are several reports of intelligence test scores by groups of rural and urban children in other countries. This paper presents a critical comparative study of results obtained in India with 'spiral omnibus type verbal group tests' in Hindi and Panjabi. In general the urban children seem to have a significant advantage; that is noticed in the mean total scores. But there is no significant difference among the elements, specially of 'number series' and of 'reasoning'.

14. A preliminary study of a set of ink-blots.

B. KUPPUSWAMI and H. S. ESWARA, Mysore.

Long ago Whipple standardized 20 ink-blots to gauge the fertility of visual imagination.

The present paper reports an attempt to standardize a set of ink-blots to study the spontaneous imagery and creative thinking among school students.

To start with, 40 ink-blots varying in size and complexity were prepared, 20 being bilaterally symmetrical and 20 odd-shaped. Children ranging in age from 9 to 15 of the middle and high school classes were given these blots in small groups in two sessions. On the basis of the total number of responses and number of different responses 10 cards were selected. These cards were given to a sample of 60 children of age groups 13, 14 and 15 of both sexes studying in IX standard.

It was found that boys gave larger number of responses than girls but the difference between the means was not significant. Similarly with increase in age there is increase in number of responses; but these differences also were not significant.

It is proposed to extend the study and standardize the test.

15. Effect of practice on test scores.

MANJULA MUKERJEE, Calcutta.

The objective of this study was to test whether previous experience of a similar test had any effect on the scores of the test taken afterwards.

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The scores of three pairs of tests conducted over three different groups of persons were analysed. It was found in all the three samples studied that practice had some effect on test scores and this effect was significant statistically.

16. Validation of Madras Picture Frustration Study (MP-F). through Trend Analysis.

B. C. MUTHAYYA, Madras.

An attempt was made to verify the interpretative assumptions through investigation of the internal consistency of the MP-F by trend analysis. It was hypothesised that if an individual has built up stable and adequate patterns of reaction to frustration, he will meet each situation in its own setting and will react to it in an appropriate manner without the interference of residuals from his previous behaviour. If on the other hand, his reactions are unstable, perhaps an expression of conflict, his behaviour in a later situation may represent a compensation for or a reaction against his previous response. Thus it was assumed that protocols showing trends reveal less extra-punitive reaction than protocols without trends. In order to verify this assumptions, a trend analysis of 50 protocols of the MP-F was made in order to discover protocols with trends and without trends. While deciding the significance of the trends, Rosenzweig's tentative standards of significance were made useful. Means were calculated for the Extrapunitive reaction for the groups, with trends and without trends and the critical ratio between the Means was found out. The results, though not significant, revealed that the group showing trends in the MP-F records expressed less Extrapunitive reaction that those without trends verifying the hypothesis that the appearance of trends is an indication of unstability and conflict in the expression of aggression. The results suggest the feasibility of this validational procedure particularly to controlled projective techniques like picture frustration study.

17. A Comparative Study of Psychological Scaling Methods.

R. K. MISRA and P. K. DUTT, Lucknow.

A comparative study was made of the methods of paired comparisons and rank order. One hundred University students were asked to express their preferences for ten vocations both by the methods of paired comparisons and rank order. The rho (co-efficient of correlation from rank differences) for rank values of the items scaled by the two methods was ·90. A linear curve was obtained when the rank values for the two methods were plotted on graph. It is suggested that the rank order method might be taken as a moderately good substitute for the method of paired comparisons provided that the number of items to be scaled does not exceed fifteen or so.

18. Form of Bengali language as a determinant of ideas contained in the items of a foreign personality inventory.

DEBABRATA BANERJEE and AMAL KUMAR MALLICK, Calcutta.

This paper reports the first part of a study involving the effect of two forms of Bengali language, 'chaste' and 'colloquial', on the ideas of meanings of verbal test-items.

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In this part of the experiment 12 judges (students and degree-holders), both male and female, were asked to rate 12 statements of H. J. Eysenck's 'A Short Questionnaire for the Measurement of Two Dimensions of Personality', translated in two forms of Bengali language (chaste and colloquial). The judges were to rate each of these items on a 5-point qualitative scale of 'satisfactoriness'—the criterion of satisfaction being the effectiveness in the expression of ideas contained in the original statements.

After testing the reliability of the judgments offered by each of the judges, the results were quantified and the average values for each statement of the two forms were worked out. The different values (average) thus obtained for the different groups of judges—(male-female and student-degree-holders) were subjected to correlational analysis.

The high values of correlation (all above +·90) indicated very close relationships between the judgments of different groups as to the nature of satisfactoriness in the expression of the ideas carried by the original version (English) of the test. This suggests that so far as the present group of judges are concerned there is no appreciable difference in meaning for the two forms (colloquial and chaste) of the Questionnaire.

The investigation, however, awaits a final conclusion, after the results of the use of these two forms on a group of pupils of lower age are available to the authors.

19. A study of relationship between test scores and achievements in some school subjects.

RAMANATH KUNDU, Calcutta.

The paper presents the results of a study carried out to determine the relationship between test scores and achievements in some school subjects. Two tests, one to determine intelligence quotient and the other to assess concrete intelligence, were administered on a group of 70 students of a Calcutta school. The marks obtained by the students in different linguistic subjects such as English, Bengali, etc. were collected from the school record.

Significant positive correlations between intelligence quotient and marks obtained in languages indicated that attainment in language is sufficiently related to abstract intelligence. So the scores of abstract intelligence test could be regarded as predictor of success in learning languages. The concrete intelligence test was found to be not suitable for the same purpose.

The findings of the study suggested that elaborate investigation in this line is worth attempting. The usefulness of the two tests for predicting success in some specific subjects could also be investigated.

20. Psychological tests in the selection of M.S.W. Students.

S. DUBE, Baroda.

A pilot study was conducted to verify how far the Psychological tests are helpful in the selection programme of the Faculty of Social Work of Baroda University. A brief summary of the psychological testing is presented to emphasize the role of the testing in the selection of the trainees for the general training of Social Work at post graduate level. The selection criteria (specified in terms of 11 Social Work Potentials) and the test battery is discusstd at length.

Correlation was made on a five point Rating Scale between the assessment of social work potentials of 24 students (1959-61 batch) by selection test, retest and

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the judgement of their supervisors at the end of the training of two years. All the correlations are positive but varying in importance from ·1 to ·9 in the assessment of different potentials. Suggestions are made for further carrying this investigation, for evolving a common frame of reference for the Raters and validating the presennt Test battery with other external criterion.

21. Differential weighting of linear-transformed scores according to the difficulty levels of test items.

SUSHIL KUMAR, Calcutta.

In tht linear transformation of scores (X or Z) equal weight is given for equal differences in raw scores (The differences between z scores of 30 and 60; and 60 and 90, will be the same). Although in many cases it is not the best estimate of the ability. It is suggested in this paper that we divide the test in three parts according to the range of the difficulty of items e.g. $p \geqslant 0{\cdot}70$, $p \leqslant 0{\cdot}30$, and $0{\cdot}30 < p < 0{\cdot}70$. We compute mean and standard deviation of each part and compute z not by the formula.

$$\frac{Xi - X}{\delta}$$

where X and δ are the mean and standard deviation of the total score. And X_i is the raw score of ith individual but by $\frac{\Sigma Z_i}{\delta_z}$ where δ is the standard deviation of the distribution

$$\Sigma Z_i = Z_{Ai} + Z_{Bi} + Z_{Ci}$$

A, B and C are the three parts of the test. A short method of compulting $\frac{\Sigma Z}{\delta_z}$ or Z-score is also given.

22. Estimation of reliability of the mean of artists' ratings on their quality for purpose of potential-artist-selection scheme.

PRYANSHU SEKHAR BHATTACHARJEE, Calcutta.

Qualities selected by the 50 expert artists for successful operation and control to become a painter have been subjected to ratings by exponents in the line of art. Three such exponents rated the required qualities in a five point scale has stood for a statistical estimation of reliability of the same. Robert. L. Ebel's method of ascertaining rating-reliability has been accepted in this survey.

Variances of traits and errors have been estimated to be 1·784 and ·573 respectively with 11 and 22 degrees of freedom. The r_{11} has been found ·413 which is satisfactory and has been accepted.

23. Construction of a psychological scale of thickness.

AMAL KUMAR MALLICK, Calcutta.

An experiment on subjective thickness has been performed for constructing a psychological scale of thickness. Data have been collected for the thickness of 1·25, 3·75, 6·25, 10·00, 12·50, 15·00 and 18·75 mm. Inter-judgment differences due to the feeling of thickness with righthand and lefthand are not statistically significant.

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The thickness of 4·96 mm. is found to be judged as half of the thickness of 10 mm. This subjective thickness corresponding to a physical thickness of 10 mm. is taken as the unit and is termed as 1 Dicke. Similarly the subjective thickness corresponding to the physical thickness of 4·96 mm. is regarded as half Dicke. Thus a scale of psychological thickness has been constructed. The functional relation between the physical and psychological scales have been determined both graphically and analytically. Some empirical equations relating the physical thickness in mm. to the psychological thickness in Dicke has also been deduced.

24. Relation between Kuder Preference Record and a Non-verbal Interest Inventory modelled after it to suit Indian conditions.

S. CHATTERJEE and MANJULA MUKERJEE, Calcutta.

The paper discusses a study of the relation between the scores obtained on Kuder Preference Record (vocational) and Chatterji's Preference Record—a non-verbal interest inventory modelled to some extent after the former inventory. Product moment correlations were calculated between the comparable scales. The results are discussed in the paper.

25. Stability of measured interests.

S. CHATTERJI and MANJULA MUKERJEE, Calcutta.

The Kuder Preference Record and a non-verbal interest inventory (CPR—1158) was administered to a group of 23 freshmen. After one year when these students were in the second year of their training the testing was repeated. Correlations between initial and final scores were computed in order to determine stability of measured interest under the influence of the training imparted and the passage of time. Generally it could be said that stability is quite high in those fields which are directly connected with the training during the intervening period.

26. An experimental study of interviewer bias.

A. S. PATEL, Baroda.

The present investigation has been undertaken with a view to studying experimentally in an interview process the bias effect resulting from some peculiar characteristics of the interviewer, e.g., influence of sex, training, and communalism of the interviewer as well as his knowledge about the status of the interviewee. Hundred interviewers were sampled for this purpose in such a way that half the number were men and half number women, half experienced teachers and half fresh graduates, half number Gujaratis and remaining half Maharashtrians; one half number of interviewers were supplied with particulars regarding the status of interviewees and the other half did not have any knowledge about the interviewees. Sixteen high school pupils—both boys and girls, Gujaratis and Maharashtrians—served as interviewees to be interviewed on a specially prepared general knowledge test. Each interviewee was specifically and differently tutored beforehand regarding the answers to the questions in the test so that the score to be obtained by each was objectively fixed.

The statistical analysis of the interviewees' performances assessed by the interviewers revealed the following interesting findings :—

(1) Thre was a very high extent of subjective bias of interviewers in judging even most objective data.

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(2) There were significant sex differences as well as community differences, but no training differences in judgment.
(3) Significant differences were also observed in assessment when the interviewer of one sex or one community evaluated the performance of interviewees of same and different sex or community.
(4) There were also significant differences in judgment when the interviewers had and had not knowledge about the status of the interviewees.

PERSONALITY

27. An experimental study of the relation between temperamental factors and attitudes.

E. I. GEORGE, Kerala.

The work reported in this paper is an investigation of the possible relation between social attitudes, interests and personality traits. These were tested by means of the public opinion inventory of Eysenck and Melvin, the Allport Vernon study of values, and Guildford's inventory of personality factors. The sample consisted of 500 British middle class people. The scores were treated by means of factor analysis, analysis of variance and item analysis.

Four orthogonal centroid factors were extracted after rotation identified as follows : I. Tough mindedness—tender mindedness, II. Neuroticism, III. Radicalism —conservatism and IV. Extroversion—introversion.

Analysis of variance yielded significant differences between groups of political parties, between radicalism-conservatism, but not on the tough-mindedness—tender-mindedness and on all the interest categories except the political value.

Analysis of items measuring toughmindedness—tendermindedness and extroversion—introversion indicated that there was a positive relationship between these two variables.

28. Differential Ideal Self Image of Engineering Students.

H. K. MISRA, Kharagpur.

High and Low achievers of an Engineering Institution were asked to rate each of 45 personality traits on an 8 point scale for their relevance to success in the profession of engineering. The differences in ratings by the two groups were tested by the Mann Whitney test. Nineteen out of the 45 traits showed significant difference. The nature of these traits and the implications of the findings are discussed.

29. Standardization of revised adjustment inventory (Rai).

PRAMOD KUMAR, Allahabad.

The revised Adjustment Inventory (RAI) is developed to screen the poorly adjusted college going students. It consists of 40 'Yes—No' type items taken from Asthana's, Woodworth's and Sanller's well known personality inventories.

It is a self-administering inventory and takes 20 to 25 minutes to answer it.

The sample consists of 229 randomly selected male engineering students with a mean age of 20·5 years. Mean, median, standard deviation, Skewness and Kurtosis are calculated.

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Split-half reliability (correlating odd-even items) is found to be ·88 with an index of reliability of ·93. The test-retest reliability is also computed. It is found to be ·81 with an index of reliability of ·90 with one week's interval time.

The percentile norms are also provided for the purpose of interpretation.

30. A study of the relationship between intelligence and some dispositional traits.

ADITI BHADURI, REBA BANERJEE and TAPATI ROY, Calcutta.

The present study aimed at determining the relationship, if any, between intelligence (abstract) and four dispositional traits characterised by Bernreuter Personality Inventory (BPI), viz., B1 (Neuroticism), B2 (Self-sufficiency), B3 (Introversion) and B4 (Dominance).

The test battery consisting of : (1) Bengali version of BPI (shortened into 30 items by the Indian Statistical Institute) and (2) a Group Intelligence test in Bengali constructed by Dr. G. Pal and Sri S. Bose, was administered to a sample of 50 girls reading in class XI of a Calcutta Multi-Purpose School, their age ranging from 15 to 17.

The constituent eleven sub-tests of the said Group Intelligence test were classified into two categories, verbal and numerical. Each of the four traits was correlated with the total intelligence score (I_{ts}) as well as with the other two scores corresponding to the verbal (I_v) and numerical (I_n) categories, rendering finally a correlation matrix of 12.

The matrix revealed three significant coefficients of correlation, each in case of numerical, verbal and total scores of the Intelligence test used. While the numerical portion of the Intelligence test was negatively correlated with Neuroticism, the verbal part and the total test produced positive correlations with 'Dominance' and 'Self-sufficiency' respectively. The range of correlation values was found to exist between +·01 and −·41.

The result corroborates the findings of earlier studies reported by Lorge, Nemzek, Stagner and others, that personality traits as measured by BPI are, in general, poorly correlated with intelligence test-scores. However, some differential results are observed when the traits are individually considered against the total and part-scores of the intelligence test employed here.

31. Validiation of the discriminative capcity of the Guilford Zimmerman temperament survey with reference to the temperamental profiles of student nurses, school teachers, and University boys and girls.

G. C. GUPTA, Delhi.

An adapted form of Guilford Zimmerman Temperament survey is administered to five samples of student nurses, University boys, University girls, school teachers (males and females). Significant differences between the means in the traits which this survey assesses is found. An attempt is made to validate the test with respect to only those traits on which such significant differences between such temperamental profiles were observed. The study is still being continued.

32. Personality Pattern of Adolescent Children with Rorschach Test.

KRISHAN BIR, Delhi.

The aim of the present investigation was to determine the personality pattern of adolescent Children with the Rorschach Test.

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The Rorschach Test was administered to sixty (60) school children aged 13 years to 14 years 11 months. Scores for twenty-nine (29) Rorschach variables were inter-correlated and the matrix thus obtained was factorised by Burts Method of Simple Summation.

Three factors were extracted :—

1. Factor of 'General Productivity' accounting for 29·88 per cent of total variance.
2. Factor of 'Instability' contributing 13·75 per cent of the total variance.
3. Factor of 'Instinctual Drives' sharing 9·61 per cent of the total variance.

33. Szondi patterns in Musicians : An examination of the Szondi signs of 'Musicality'.

MANAS RAYCHAUDHURI, Calcutta.

Susan Deri, a student and co-worker of Lipot Szondi, has proposed in her manual of Szondi Test that there are at least 7 Szondi Syndromes or preference-modes which significantly differentiate artists as well as musicians from normal people. The present study examined the discriminative power of those Szondi signs of 'musicality'.

Two groups of S's are used in this study (*i*) The experimental Group consisting of 30 successful professional musicians. The list of the musician group were compiled by three known expert and critic of music and (*ii*) The control Group consisting of 30 adults engaged in professions other than music or art.

A Chi Square test was made of those 7 signs of musicality in an effort to distinguish the musician from the control Group. The 7 signs as a group failed to significantly differentiate the groups; only one of those 7 individual signs i.e., 'minus hy' was significant in differentiating the groups. Considering that these 7 signs are regarded as the most important Szondi pattern of musical person, this study seriously doubts the usual mode of Szondi Test interpretation. It is suggested that further research should be geared toward remaking the present rationale and/or developing a new set of stimulus pictures selected on a different theoretical frame.

CLINICAL PSYCHOLOGY

34. Schizophrenic language.

N. N. CHATTERJI, Calcutta.

The language of the schizophrenic patients often becomes incomprehensible as the construction of the sentence undergoes a peculiar disorganisation. Freud has shown that this disorganisation takes place when attempt at restitution is made of the withdrawn libido to the real objects but becomes unsuccessful. Author has tried to show that the disorganisation in the speech of the schizophrenics takes place due to regression as it takes up the magical character of infancy and also because it takes up the concrete from in contradistinction to the abstract form of the normal persons. Moreover, ego's control being weak working of the primary processes makes it further distorted.

35. A Problem Child—What guidance means to him.

SUDHIR PANCHBHAI, Calcutta.

The guidance work in most of the educational institutions in India is not satisfactory. Education is meant for the total development of a student's perso-

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nality and a School has an important role to play in this respect. Unfortunately old and non-psychological ways of correcting the student's behaviour have not been totally abandoned and hence the true goal of education is not yet fully realised.

In most of the institutions we find some problems regarding student's behaviour, and there are at least one or two per cent of problem children in each. Such children are generally so rigidly tackled that their behaviour becomes more complex in the later stages of development. In this paper, attempt has been made to show how a psychological approach can help the child achieve his goal and how the general notions regarding him may be changed. A somewwhat new technique has been adopted to have a better teacher-pupil relationship in schools. The case history cited is elaborate and indicative of various aspects of counselling procedure. Further, it has been noted that the behaviourial side of a student's development is directly and positively related to his academic achievements and by tackling the former aspect properly better results may be obtained in the latter.

36. An Experimental study of Alcohol and Drug addiction.

D. RAKSHIT and J. N. GUPTA, Calcutta.

From the accumulation of numerous scientific case studies of Alcohol and Drug addicts under a long term project it has been found that every individual has complaints of one or more of the following illnesses.

(1) Nervous exhaustion, characterised by fatigue, insomnia, irritability.
(2) Anxiety group characterised by palpitation, excessive micturation, vertigo, shortness of breath, gastro-intestinal disturbances, trembling, agitolalia, etc.
(3) Vasovagal attacks, myosis.
(4) Hysteria group characterised by any number of pseudo-neurologic states of paralyses, paresis, contracture, etc.
(5) Depression, paraphasia, etc.
(6) Mysophobia and other forms of morbid fears.
(7) Impotency, enuresis, emission, delirium tremens, amnesia, dementia.

In determining the Psychological factors in prevention and treatment of Alcohol and Drug addicts it is found out that there is no fundamental difference between the psychology of the Alcoholic and the Drug addict.

Two forms of Psychological examinations are employed for diagnosis and treatment of the addicts. A cross section examination in which the complaints are focussed upon and the present status determined; and a longitudinal examination in which the history of the patient and his illness are determined. The former makes for diagnosis and the latter is more useful in treatment.

37. Metabolic Deficiency and Behaviour Pathology.

S. N. SINHA, Patna.

The present paper attempts to examine the effects of qualitative and quantitative nutritional deficiency (evidenced in lowered metabolic conditions), on varied forms of normal and pathological behaviour. From an appraisal of studies on quantitative dietary deficiency (as in food deprivation or semi-starvation) it becomes clear that the normal psychological processes of thinking, imagining, perceiving and learning are significantly affected by it. The effects of quantitative deficiency has not yet been related to clinical manifestations of behaviour.

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Qualitative nutritional failure or inadequacy can cause certain behaviour anomalies. Inadequate provision of vitamin B complex components in the diet, has been found to result in increased emotional reactivity in human S's. Nutritional failure due to lack of absorption of the dietary elements causes metabolic dysfunction, which results in pathological manifestations of behaviour. The effect of acute depletion of organic elements such as Magnesium has also been found to produce seizure states both in human and animal S's.

It is hoped that from an appraisal of the behavioural effects of nutritional failure or inadequacy, the genesis of psychopathological manifestations can better be understood in terms of a psycho-biochemical approach. However, the little done and the vast undone suggests the possibility of further fruitful explorations in the field of psycho-biochemical research.

38. Behaviour of the Subjects during Testing Sessions and its Effect on Subjects Performance.

MYRA SEN, Cooch Behar.

The present investigation aimed at finding out how far poor performance in conceptual tasks by Schizophrenic patients has been due to their deficiency in that ability and how far it could be accounted by other disorders like poor co-operativeness and lack of attention.

Two groups of subjects, one comprising of 35 Schizophrenics and the other 25 Normal, individually matched on variables like age, sex and education have been given the Haufmann-Kasanin test, as a test of conceptual ability and the Pass-along test as a test of intelligence. Subjects co-operativeness and attentivity have been carefully rated. Only 23% of the Schizophrenic subjects have shown marked disorders of co-operation while none of the Normal have manifested such behaviour. None of the Normal have shown any disorder of attention while about two-third of the Schizophrenic cases have shown various disorders.

The Haufmann-Kasanin test was administered in the modified way introduced by the present author and thus two different varieties of success, success with full credit and that with half credit standing for success within 25 minutes of performance and successful reproduction after demonstration of the solution, respectively have been assessed. Schizophrenic cases have shown much poorer performance in both the intelligence and conceptual tests, when compared to that of normal.

The general intelligence of the Normal subjects as assessed by the Pass-along test have been more closely associated with their achievements in the Haufmann-Kasanin test than that of the Schizophrenic subjects. Co-operativeness and attentivity of the subjects, in general, have been found to be closely associated with their achievements in the conceptual task as well as Pass-along test.

In the light of the present findings, it can be concluded that while interpreting test-performance one must take into consideration subjects co-operativeness, attention and like factors, specially in case of the Schizophrenics who are liable to have disorders in those fields due to their disease process, as disturbances in those fields can obstruct full utilization of subjects' ability. However, one should not stress its importance to the degree of dis-regarding the fact that Schizophrenics do suffer from deficiency in some abilities.

39. Learning under Hypnotically induced anxious and non-anxious conditions.

J. P. DAS, Cuttack.

Six somnambulist Ss were required to learn two lists of nonsense consonants varying in difficulty level. The learning was undertaken under high (HA) and low

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(LA) anxiety conditions. Anxiety was introduced by hypnotic suggestions during the somnambulic phase. It was hoped that by this method, transitory anxiety can be effectively induced and removed within a relatively short period, so that each subject becomes his own control while comparing the effect of anxiety and its absence on learning. The results show no difference between learning scores of H.A. and L.A. groups, although some characteristic difference could be apparent between the performance of the two groups, which corroborate comparative studies on incentives.

SOCIAL PSYCHOLOGY

40. Studies on some Aspects of Interaction in Leaderless Problem-solving situation : I. Participation.

PRABHAT K. MUKHOPADHYAY and JHARNA MUKHOPADHYAY, Calcutta.

On the basis of an assumption in group-dynamics that participation of the group members helps to an all-round betterment and economy of solving cognitive problems, the present experiment is designed by (i) varying the group-structure in sex-variant homogeneous group, (ii) nature of the problems and (iii) the experimental control as free-lance and restricted discussion as models of participation variance. Tape-Record Amplifier was used as the agency of experimental control. Post-discussion self-ratings and the number of correct answers respectively were taken as the subjective and objective criteria of measurements. Two groups of 40 school students were admitted into this experiment of which 10 sex-variant subgroups were the actual participants. One group was allowed to discuss freely over a problem where for the other it was restricted. It has been observed that free participation is a significant process to tap the potentials of the individuals for cognitive problem-solving without having a restriction either by group structure or by the nature of the problems. This process becomes optimally productive if the members are quite aware of their roles.

41. Stereotypes regarding Linguistic Groups.

B. KUPPUSWAMY and M. PARASIVAMURTHY, Mysore.

It is a familiar fact that after independence there was intense feeling among the people of the various states to reorganize the states so that all the people speaking one language form into one state and come under one administration. There was also the fear that unity of the country would be affected if regional languages become very predominant.

The present study was started in order to find out the stereotypes of the students in some colleges of Mysore city regarding themselves and regarding the people in other states.

The 50 attributes prepared by H. Narayanamurthy in 1953 were used. 150 Psychology students, 64 boys and 86 girls, studying in B.A. class were tested in 1959. The most frequent attributes with percentages were found for each of the 14 groups. Also the stereotype score was found by subtracting the average negative score from the average positive score.

It was found that the self picture of the group is very favorable and endorsed by a large majority. The highest positive scores were obtained by Mysore, Kashmir and Bengal while the highest negative scores were obtained by Madras, Maharashtra and Kerala.

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42. Mediated Transfer of Attitudes.

J. P. DAS and P. C. NANDA, Cuttack.

Attitudes can not only be acquired, but may also be transferred like verbal CRs. This was shown by associating a nonsense syllable with the name of a tribe, then developing a favourable or unfavourable attitude towards the nonsense syllable and subsequently testing whether such an attitude has been transferred to the tribe. Two nonsense syllables and two names of tribes were chosen as stimuli in a counterbalanced Sensory Preconditioning (SPC) design requiring four groups of 20 *Ss*. A notable feature was the use of probability learning during the conditioning period; the probability of occurrance of 'good' or 'bad' after a nonsense syllable being. 85. Transfer, which was successful, was tested in two ways : (1) by requiring *Ss* to choose 10 out of a mixed list of 20 favourable and nonfavourable attributes for each tribe and (2) by rating each tribe on a semantic differential scale of good-bad. It was suggested that SPC may be essentially indistinguishable from classical conditioning.

43. Impact of Caste on Social distance among Gujaratis.

A. S. PATEL and U. C. SHROFF, Baroda.

The present investigation is an attempt first to construct a scale to measure social belongingness or distance, and then with it to study the nature of inter-relationships between various castes in Gujarat from point of view of social distance. Accordingly, 'a measure of social belongingness' on a nine-point scale was constructed on line of modified or extended Bogardus scale and this was included in the questionnaire prepared to study the various aspects of social relations. The data were gathered on a sample of 230 Gujarati members of different upper and lower castes, spread over varied strata of socio-economic and educational levels. The main Gujarati castes with respect to whom the nature of social relations of above sampled Gujarati population was studied were eight castes, namely, Patidar, Bania, Brahmin, Harijan, Mochi, Kachhia, Hajam and Vaghri.

The analysis of all responses to the questionnaire warranted the following inferences in general :

(1) Usually, a person of one caste had most cordial and closer social relations with persons of the same caste and comparatively less intimate relations with members of other castes.

(2) As viewed by Gujarati sample on the whole, the order of castes from nearest to most distant stood thus : Patidar, Bania, Brahmin, Harijan, Mochi, Kachhia, Hajam and Vaghri.

(3) For most sub-groups, Patidar stood the nearest and enjoyed the confidence of most, while Vaghri was the farthest for admost all.

(4) There was a tendency with lower caste members to view with the eyes of upper caste members.

(5) The lesser the distance, the higher were the liking scores an the proneness scores.

(6) Opinions about lower castes were based on lesser experience or contacts.

44. A study of Social Distance in a Group.

BIMALESWAR DE, Muzaffarpur, and JAIBALLAV SINGH, Ranchi.

The present paper is based upon the findings of a study undertaken by the authors on the Topography of a Group. In this study the structure of a group

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consisting of twelve male students of the final year Psychology Honours Class of Ranchi College was analysed by Moreno's sociometric technique. With this technique an attempt was made to evaluate quantitatively the influence of such a variable as group belongingness on the 'friendship choices' of the members.

The quantitative study of the topography of the group was made on the basis of a preference scale, the two limits of which were : +100% and—100%. The psychological limits of these two values are : most dislike or least preferred, and most liked or most preferred.

The members were asked to locate their preferred friends and also non-preferred ones on this scale. From the data obtained by administering the above scale, the values of social distance from each member to the group and that from the group to each member were calculated by the formula : if the preference expressed by one member for another is 100%, then social distance between them is equal to 0. The social distance, therefore, between any two members has been obtained by calculating the difference between the preference value and 100, which is the maximum on the scale. For example, if A's preference value for B is 50, then B's social distance from A is : 100—50=50. Similarly, the maximum value for non-preference on the scale is—100%, which means total rejection. Here then value of social distance will be : 100—(−100)=200, the maximum value of social distance possible according to the scale.

On the basis of the values of social distance obtained, such factors as 'attractiveness', 'forces of attraction and rejection' were operationally analysed and members were located in a group space in terms of their attractiveness, their location, i.e., whether in the inner circle or in the periphery of the group space, relative centrality, and forces of attraction and rejection operating in the group space. In addition to all this, such phenomena as leadership, sociometric status and academic adjustment were also enquired into.

45. Nature of Stereotypes : A Suggestion.

R. K. MISRA, Lucknow.

A stereotype is defined as a hypothetical construct which refers to the process of establishing and maintaining a state of psycho-social homeostasis. We come across different situations at every movement in our everyday life. There is thus a constant demand to maintain a psycho-biological and a psycho-social balance with our environment. Stereotypes help us in this effort. It is proposed that the nature and process of stereotyping could be understood well if stereotypes are viewed as varying along a few dimensions which may also be taken as "stereotype-characteristics". These may be mentioned as openness, activation, selection, learning, mechanization, cumulation and symbolization. Stereotypes are a pliable control system, amneable to subsequent modification, maintaining constant communication with the environment, are highly selective in incorporating their content, gradually acquire a ritualistic character, are not hostile to their "family members", and possess a symbolic value furnishing an individual with units to represent his experiences.

46. The Spatial Factor and Pair Formation in Small Discussion groups.

AMITAVA CHATTERJEE, Kharagpur.

The dynamics of small discussion groups depend mainly upon the interaction-transmission. But the interactions between members are in some way dependent upon the spatial factor. In other words, the seating arrangement in

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small discussion groups help to determine the individuals between whom the interaction process will flow. This verbal altercations between members give rise to the formation of paid groupings, which again is facilitated by the seating arrangement.

The present paper is a further extension of the study on small discussion groups. Here the observations of a small group, consisting of eight members are reported. The members were the participants in a short-term residential study course. The group were meeting in several sessions to discuss different case study problems. The data for the five sessions are analysed here. The seating positions of the members are quantified in order from the left of the leader's Chair. The order of interaction of each individual member is noted and from that order the pair groupings are identified following the particular analytical design developed by Josephine Klein. It is observed that the seating positions of the members remain consistent to the span of time. It is also noted that there is a definite relationship between the pair groupings and the spatial factor in small discussion groups.

47. Difference of opinion in the educated public about some Socio-political issues.

AMAL KUMAR MALLICK, Calcutta.

Opinion of educated people on some socio-political issues has been surveyed. They have been found to possess definite opinion, favourable or unfavourable, about all the issues except one and their response pattern is statistically significant beyond ·01 level.

The sample is broken down into different sub-groups on the basis of sex and economic status. The difference in opinion between the sub-groups is found to be significant (a) when the general opinion has not at all crystallised and (b) when it has somewhat crystallised with no significant trend. But the difference in intra-group opinion is not significant in the case of those issues about which inter-group opinion (i) has either highly or considerably crystallised and (ii) has a definite trend even if it has not appreciably crystallised. Further investigations in this direction is being carried on by the author under a Research Scholarship Scheme of the Government of India.

48. Extraversion, Neuroticism and Conformity Behaviour.

S. D. SINGH and K. C. GUPTA, Chandigarh.

The present experiment was mainly designed to study the relationship between conformity and extroversion, and neuroticism dimensions personality respectively. A group of 64 post-graduate students, 32 males and 32 females served as Ss. They were selected and also classified into four personality groups : high neuroticism and high extroversion group, high neuroticism and low extroversion group, low neuroticism and high extroversion groups, and low extraversion and low neuroticism group. The stimulus material consisted of 10 slides, each having unequal number of white and black dots. Each slide was exposed twice to each S for a period of 1 sec. in a dark room, and after each exposure the S. was required to tell which of the two kinds of dots were larger in number. Each S had two experimental sessions : Individual session, when all the slides were exposed to the Ss. individually, and group session, when the slides were presented to the Ss along with two confederates, and each S occupied position II or III for either of the two exposures of each slides. The results of the experiment showed that the Ss conformed significantly more at position III than at position II. The low neuroticism Ss conformed

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somewhat significantly more than the high neuroticism Ss, while extroverts conformed more than the introverts, but the differences were not significant. Similarly, though females showed greater conformity than males, the difference between the two sex groups was insignificant.

49. A Psychological Analysis of Tensions.

S. V. KALE, Bombay.

It is necessary to search for common basic factors in tensions of group life at various levels—social or economic, national or international. Concentration of research at present is on two situations : (1) tension to which single individuals are liable; (2) tensions in small groups. Psychologically, the process of tension occupies a middle position on the continuum of desirability-undesirability, of scientific concepts. Tension acts as a built-in release mechanism which helps to reduce the intensity of a drive or to achieve a goal in behaviour. The continuation of the state of tension much depends on the clarity and definiteness of the goal. In the absence of definite goal, tension takes the form of anxiety, frustration, conflict or emphasis on obstacles or achievement. Especially, in conflict-situtions, the influence of social factors in individual tensions is apparent, as it is primarily the social factors that determine which actions are rewarded and which are not.

In group-tensions, the main factors that aggravate them are competition and rivalry. From well-known studies on the relation of groups to induced and forced changes such as by Coch and French, we can draw certain conclusions which can be applied to the problem of securing co-operation of people in India to planned economic change.

50. A Study of Quality and Quantity of Work, Pattern of Interpersonal Relations and Leader Popularity under Democratic, Authoritarian and Consultatives Styles of Leadership.

V. V. PENDSE, Poona.

The psychological descriptions of the democratic and authoritarian styles of leadership are given by Lippitt and White. The consultative style of leadership differs from these two principal styles in respect of making decisions, executing plans, forming interpersonal relations etc. The consultative leader-personality is expected to be more relaxed, integrating and a better builder of human relations.

To investigate the quality and quantity of work done, the pattern of interpersonal relations formed, etc. under the three leadership climates, three roughly equated groups of children were made to experience and work under one leadership climate each. One adult leader, who enacted the three leadership roles, led these groups, one after the other. He appeared to the children as a craft-teacher and tought them preparing paper-models.

Two observers took down detailed notes of the experimental sessions and rated each aspect of the leader to child, child to child and also child to leader behaviour. Three independent judges judged the quality and the quantity of work done by each group. The members of each group answered a short questionnaire and thus indicated their reactions to the leader-behaviour.

One of the important results of the study was :—

(i) the consultative leader was the most popular and was admired and respected;

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(ii) the authoritorian leader was respected but feared, and was unpopular with the group-members;

(iii) the democratic leader was neither admired, nor respected, nor feared by the members of his group, and he was also not popular with them.

VOCATIONAL & INDUSTRIAL PSYCHOLOGY

51. Union Attitude and Job Satisfaction.

DURGANAND SINHA and K. C. SARMA, Allahabad.

The relationship between attitude towards union and job satisfaction was studied on a sample of 100 workers in a light engineering factory by the use of specially constructed interview schedules. There was a significant negative association between the two ($r = -0{\cdot}47$). Thus, workers with more favourable attitude towards the union were on the whole dissatisfied with the job.

Of the personal factors, marital status and length of union membership were significantly related to job satisfaction. Age, education and income did not show any significant relationship.

None of the personal factors were found to influence union-attitude significantly. Using multiple regression analysis, information on marital status, number of dependants, total income and length of union-membership combined were significant to enable prediction of job satisfaction score.

The results are discussed.

52. Interest Pattern of School Teachers.

R. G. CHATTERJEA and G. B. SAHA, Calcutta.

The present study is an attempt to show the degree of difference in the interest pattern of school teachers of either sex in different dimensions of interest in the same line of strongs' VIB.

The form of quqestionnaire consisted of 48 occupations, 41 amusements, 41 curricular subjects, 19 activities and 23 personality types. The survey was conducted on a three point scale viz., Like, Indifferent, Dislike. Total number of subjects was 66—44 male and 22 female. The result of five dimensions of interest was calculated in percentage basis.

The interest pattern of the teachers are markedly alike in certain dimensions though divergences are none the less great. In matter of liking teaching in college is favoured by all, discrepancies appear in jobs like business, mechanics etc. While the curricular subjects as literature, psychology, history and amusements like travelling, picnics etc. are most favoured by the teachers.

Close resemblance seems to be present in the pattern of interest in the field of activities and personality types.

53. A study on some specific causes of Industrial Absenteeism and its effect.

SAMIR KUMAR DEY, Calcutta.

The success of an industry depends on the reduction of Absenteeism. The worker is always confrotned with two diverse motives—the desire to do work and the desire to avoid it. The triumph of the later motive often leads to Absenteeism.

The present study was conducted in a Jute Mill and relates to the second

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motive and the factors that affect it. The study was based on the absenteeism rate prevailing in the Jute Mill and the causes given to it. The causes were further analysed to get into a meaningful whole, and the points which the study included were—

(i) the study of production in the department where absenteeism rate was higher;
(ii) industrial relationship that existed in that shop.

The main causes of industrial absenteeism from the study was concluded to be due to the following heads :—

(i) Physical condition of working place	9%
(ii) Facilities provided by the Company	6%
(iii) Frequency of family illness and social causes	19%
(iv) Consciousness of responsibility	2%
(v) Understanding of Company's policy	4%
(vi) Frequency of employees' illness	27%
(vii) Vices of the workers	6%
(viii) Worker-supervisor relationship	18%
(ix) Earnings and absenteeism	6%
(x) Psychological factors	3%

From the study it is concluded that after the working of Employees' State Insurance Scheme, authorised leave has increased in relation to unauthorised.

Further, it is found that where higher is the rate of absenteeism lower is the efficiency there (in the department), with corresponding repercussion on the labour relation and labour condition in the organisation, resulting in the increase of labour turn over, disputes and frustrations etc.

Absenteeism is the end result of three fold causes i.e. those relating to the conditions in an industry, those to the conditions outside it and the rest relating to mental life of the worker.

54. Job Satisfaction and Absententeeism.

DURGANAND SINHA and PARMAJIT SINGH, Allahabad.

Absence of personnel from work has a very disorganizing effect on work-efficiency. The present investigation has been designed to investigate the relationship of job satisfaction with work-attendance. It also throws light on the operation of certain personal factors.

In the works of a large steel plant, 72 workers with high absentee rate (20 per cent or more) and 156 with low rate (3 per cent or less) mere isolated. Out of these, 50 workers from each of the groups were randomly selected for study. A job satisfaction schedule was applied and each worker was also rated by the foremen as to his attendance, enthusiasm for work, satisfaction, loyalty to company and overall assessment.

Using the Spearman Brown formula, the job satisfaction schedule yielded a reliability coefficient of ·84. Comparing the job satisfaction scores of the high and low absentee groups, the difference was found to be significant ($t=4{\cdot}53$; $df=98$). Workers who were more frequently absent were much less satisfied with their work than the regular works.

Scrutinizing the different areas of job satisfaction, it as observed that workers with high incidence of absence tended to be relatively less satisfied than regular workers with regard to nature of work, supervisors and supervision, company—policy and wage and security. The difference was, however, significant only with

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regard to be last one. Comparing the ratings, it was observed that regular workers were significantly rated "better" and those with high incidence of absence as "poor" by the foremen ($t=5.046$; $df=98$). Of the personal factors, only income level was found to have significant relationship to attendance, high-income group being the most regular and middle income the least regular.

The importance of job satisfaction as a factor behind absenteeism is stressed. It can be said that a low absentee worker is on the whole satisfied, belongs to the higher income group, and is looked upon as generally satisfactory by his foreman. The high absentee worker is less satisfied, belongs to the middle income group, is a little younger, has changed his job, and is also viewed by his supervision as less satisfactory as a worker.

55. A study of Incentives and Motivation in a Group of Supervisors.

L. J. BHATT and N. S. PATHAK, Baroda.

The paper reports a study of attitudes of a group of supervisors towards various incentives. The questionnaire method, as in the study by Blum and J. Ress, was used in the first case; and in the second case, a study of the factors influencing job satisfaction was made. The supervisors who participated in this study were those undergoing training and were thus readily available for participating in the study. Their responses are tabulated and conclusions drawn for the group.

56. A study of Factors contributing towards Absenteeism among the workers in Industry.

V. S. PANDIT, Baroda.

Absenteeism, defined as the cessation of work for not less than one whole working day, is surveyed in this paper. The investigation was carried out in the Gujarat Rubber Factory and Laxmi Vijay Iron and Brass Works of Baroda. Interview and questionnaire techniques were used. The data obtained were subjected to Chi-Square test. Various relationships like (1) educational level as the cause, (2) age, (3) job dissatisfaction, (4) environmental conditions, (5) marital status etc. are studied and conclusions drawn.

57. A study of Factors that influence Co-operation in a Factory.

L. J. BHATT, Baroda.

Characteristics essential to co-operation include : (1) a common purpose, (2) recognition of mutuality of interests, (3) working together to achieve that common purpose, (4) sub-mergence of individual interests, etc.

A group of supervisors who were undergoing a certificate Course in Supervision and Foremanship were asked to respond to a check-list. The check-list was adapted from material developed for the General Motors Executive Training Programme and it includes items covering (a) conditions of work, (b) organisational information, (c) Job skills, (d) worker's attitude, (e) supervisor's attitude. Preliminary conclusions are drawn from the responses of this group. The second part is being prepared to analyse attitudes with a further investigation.

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58. Interest Pattern of the persons engaged in Engineering and Medical Profession.

R. G. CHATTERJEA and JALADHAR MULLICK, Calcutta.

The paper purports to report the result of an investigation relating to the interest pattern of engineers and physicians in five dimensions. The engineer sample consisted of 80 individuals engaged in engineering profession and all were well educated with adequate experience in the line. The physicians' group comprised of 110 persons, most of them having foreign diplomas and had a wide range of experience in their profession.

Certain curricular subjects were highly preferred by the engineers and the doctors. Those were closely associated with their profession. 'Literature' is the only curricular subject that is liked by both. Similarities in likes and dislikes of both the professional groups are found in their interest in personality types. Certain disparities, however, in their judgments so far as activities are concerned are found.

59. Qualities Desirable for Engineering students and Profession (Comparison of the Teachers' and the students' samples).

DURGANAND SINHA (Allahabad) and HEMKANT MISRA (Kharagpur).

The ratings given by 40 teachers and 30 students of an engineering institution to 45 predefined personality traits in an eight point scale were compared. The ratings of the traits for relevance to success in engineering education as well as profession showed marked similarity among the teachers and students of the same institution. The nature of the few traits in which the two groups differed and the implications of the findings are discussed.

EDUCATIONAL PSYCHOLOGY

60. An analysis of the Unstructured Composition written by children from upper-middle and low Socio-economic Status Level.

PREM PASRICHA, Baroda.

This study has been preceded by an exactly parallel one on structured composition. The purpose of this study was two-fold :

(1) To compare the extent and nature of vocabulary used by children of upper-middle and low socio-economic status.

(2) To compare the extent and nature of vocabulary used in structured and unstructured compositions.

The sample consisted of sixth class children of two schools located in the same locality but catering to children coming from different levels of Socio-economic status.

Both were boys' schools, one catering to children coming from upper-middle class families and the other to those coming from low S.E.S. level.

Completely free compositions of these children were collected. No time limit was imposed on their writing but space limit was there.

These compositions were analysed for the extent of vocabulary—repeated words and new words—as well as for the types of words used therein. Means for all categories were calculated and comparisons were made between the two levels of S.E.S. and the two types of compositions i.e. structured and unstructured.

The frequency of words used had the same order in unstructured compositions as was recorded in structured compositions with only one displacement.

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The structured composition revealed a wide extent of vocabulary than the unstructured composition.

Children from upper-middle S.E.S. level revealed a larger vocabulary than that revealed by children from low S.E.S. level.

61. Typography and Legibility of Hindi Print—A Factorial Experiment.

B. S. BHAGOLIWAL, Calcutta.

Legibility of print has been thoroughly studied in English; and specifications have been experimentally set up for different typographical factors. But most of these studies took up only one variable at a time or, at the most, two, while it has been established that interactions do play a significant role. Also there have been no experimental studies to develop specifications for Hindi. The present study is an attempt to show the influence of three main typographcal dimensions and their inter-actions on the legibility of Hindi print. For this purpose a factorial design was developed to study the role of three main factors viz. type size, line-width and leading or interliner spacing. The whole experiment was performed under strictly controlled conditions on 18 students of class VIII standard, having Hindi as their mother tongue and matched for age and their achievement in Hindi. The method for measuring readability was speed of reading aloud at a normal reading distance. The data when analysed with the analysis of variance technique reveal significant variations for the two-factor and three-factor interactions.

62. A study on Curricular Guidance.

A. K. ROY, Agartala.

The aim of this investigation was to offer curricular guidance to students at VIII standard in class XI schools with diversified courses in the Union Territory of Tripura.

The students of VIII class in 5 different institutions were the subjects of this guidance project. The number of subjects included was 678.

At first a series of orientation talks was arranged for the benefit of pupils in different institutions. In these talks Psychologist explained in general terms the purpose of the guidance scheme, the problem of educational choice at the end of VIII standard, the relation between the educational choices and their future vocational plans etc.

The pupil data were obtained from various sources—from the pupils themselves, parents or guardians, teachers, school achievement records. In addition to the above a battery of Psychological tests was constructed and administered to school subjects and result of the test battery was taken into consideration in allocating the children to one or the other of the diversified courses of curriculum. All possible attempts were made to match as far as practicable the abilities possessed by the pupils with demands of the different streams of study.

Final recommendation as to the allocation of the student to one of the six courses (technical, commerce, humanities, home science and fine arts available in the 5 schools) was arrived at not only after considering the single criterion i.e. result of the test-battery but several other factors such as socio-economic background of the pupil, his neighbourhood influences, teachers' estimates of pupil's abilities, pupil's expressed interests and hobbies in line with the elective course were also taken into account.

Analysis of results revealed that of the 678 students, about 6% of the cases were considered suitable and allocated to technical stream, 12% to commerce group,

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31% to science curriculam, 44% to humanities, 7% to home science course and 9% to fine arts group. It was further observed that 4% of the students failed to realise the relation between curricular choices and occupational goals.

The soundness of this allocation procedure, however, is to be further tested by following up studies.

63. Prediction of College success in Technical subjects on the basis of an Intelligence Test.

R. K. TANDON, Moradabad.

An enormous number of failures are observed every year specially in technical subjects of the Indian colleges. If the 'intelligence' of our students is properly measured and if right type of guidance is provided to them, much of the educational maladjustment may be avoided. Thus, the present study deals with a problem as to how far a test of general mental ability can predict college success in the technical subjects like Mining and Metallurgy, Agriculture and Engineering of an Indian University.

For this study, we have taken a test of intelligence, namely the Group Test of General Mental Ability, 20/52 Form, prepared by Dr. Jalota and the author, Laboratory of Experimental Psychology, Banaras Hindu University. They have been administered to 103, 107 and 217 B.H.U. students of Mining and Metallurgy (I, II and III year sections), Agriculture (I, II & III year sections), and Engineering (I and II year sections) Faculties respectively. The total scores and the nine subtests of the present test have been correlated with the University Examination Marks.

Our study reveals that the prediction of success in the technical subjects of Mining and Metallurgy, Agriculture and Engineering groups considered is difficult on the basis of the test used by us. However, it seems that a reliable predictive instrument would require a combination of certain measures of which an intelligence test like 20/52 Form may be one. Other significant result which appears is that different subjects correlate high in different groups. Thus, it may be concluded that different abilities contribute in varying proportions towards the college success in different groups. Consequently, different combinational measures may be required for each group considered by us. Lastly, we have found that the correlation co-efficient generally recede as we proceed from 1st year onwards in the three groups considered. Thus, the mental abilities measured by an intelligence test are more in evidence in the academic subjects of the 1st years than any of the subsequent years. Hence, a test of intelligence may carry more weight in any combinational measure for prognostic purposes during the beginning of the technical courses.

64. Science Practical Examinations—A suggestion for abolition.

S. C. CHAKRAVARTY, Mhow.

Science studies in this country are suffering from various drawbacks like want of equipment, laboratory facilities, qualified teachers, suitable text books etc. In addition to these there is a new evil that has crept up which may be termed as 'humane factor' in the conduction of practical examinations, the object of the present paper is to invite the attention of our educationists to it. To find out whether in the present educational system an equal attention is being paid to both the practical and theoretical aspects, it is necessary to determine the correlation existing between the percentage of marks secured by individual students in them in a sub-

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ject. As this is not easy due to a large number of reasons, solution of the problem has been attempted from the number of students declared eligible for supplementary examination, in certain universities, in either theory or practical indicating the subject and the paper in which only they have failed.

Out of approximately 7,600 students sitting in the different B.Sc. examinations of 1960 and 1961 of the Vikram and Agra Universities 850 qualified for supplementary in theory and 37 in practicals, the latter forming only 4·35% of the total. This clearly demonstrates that passing in the practicals is hardly a problem for our students. It may be pointed out that it is not only so in these two Universities but in a major part of the country both at the University and Higher Secondary levels. The author, on analysing the factors responsible, suggests that the practical examination should be replaced with a system of grading under a suitable scheme, the final division in the University examinations being declared on the basis of marks obtained in the theory papers only. This will prevent the boosted up results of students through lenient markings in practicals from coming in the way of their selection on the basis of real merit for admission in technical colleges in States where no competitive examination is held for the purpose and also in the selection of personnel for research, teaching and industrial organisations through direct recruitment. It is needless to mention that successful industrialisation of the country envisaged in the current and successive Five-Year Plans would depend upon the availability of the right type of scientists and technologists at the right time.

65. Attitude of Guardians towards Sex-education.

PRAKASH CHITTA NANDY, Calcutta.

It has been observed that most serious mal-adjustments and personality difficulties have their roots in early childhood and specially sex plays the prominent role among all the reasons giving a shape to it. Presently Psychologists and educationists are thinking to root out the ill effects of sex. The present author has already taken this problem and has probably been able to find out the opinions of the guardians towards the utility of the sex-education.

The method used was a questionnaire, specially adopted for the purpose. The subjects were the guardians. The items of the questionnaire were selected very carefully by a pilot survey, and with proper weightage on the five point scale. The method in social research—by Goode and Hatt was followed for the scoring purpose as it has a very high correlation with that of Likert's.

The nature of the graph plotted from the entire data obtained from the guardians shows that it has a definite inclination towards the maximum scores which again indicates that the guardians have the opinions in support of imparting Sex-knowledge. Also the high correlation indicates that their decisions were actually reliable and valid and were in favour.

66. Media of Instruction in Schools and Mental Tests.

P. S. VIVEKANATHAN and SHAKEELA BEGAM, Bangalore.

In this paper the authors try to evaluate the effect of media of instruction in schools over mental tests. These mental tests are parts of the selection tests in an industry. The sample of 41 girls was randomly collected from the population of 88 girl candidates for the job of Radio Tube Mounting. The data was analysed on the basis of different media of instruction in schools of the girls. The total sample was divided into two groups ; (1) English Group, those who studied under

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English Medium and (2) Non-English group, those who studied under any medium other than English. From the analysis of C.R. between English group and Non-English group, the following conclusions are drawn :

(1) English group is better in Mental Tests than Non-English group.

(2) As far as dexterity tests are concerned English group is equal to Non-English group.

(3) On the whole, the English group is superior to the Non-English group. Admittedly the sample for this study is very small and so from this study any generalisation is impossible. But it is hoped that the present study may pave the way for further and intense study in this line.

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SECTION OF ENGINEERING AND METALLURGY

President : DR. V. CADAMBE

Abstracts

(1) ELECTRICAL & ELECTRONICS

1. The irregularities in the F_2 region of the ionosphere and the fading of radio signals.

S. S. BANERJEE, S. C. CHAKRAVARTY and P. K. MUKHERJEE,
Varanasi.

The irregularities in the F_2 region of the ionosphere were studied with the observations of fading of a single radio wave reflected from the ionosphere at vertial incidence employing the well-known spaced receiver technique, with high frequency pulses locally generated at the frequency of 7·0 to 7·3 Mc/sec. Such observations were also possible sometimes at oblique incidence with c.w. transmissions from A.I.R. Delhi on 15 Mc. band.

The irregularities studied in the present investigations included the measurements of drift velocity, line-of-sight r.m.s. velocity and the estimations of the size of the irregularities and the angular spread of the radio waves scattered by them. The uniform movement of the irregularities was studied by determining the drift velocities from the time-shifts of similar fading patterns. In some cases when the time-shifts between the fading patterns could not be visually estimated, the drift velocity was determined from their cross and auto-correlagrams. From the several records taken during the period from Nov. 1960 to March 1961, the drift velocities of the irregulalrities in the F_2 region were found to lie between the range of 15 to 70 metres/sec. and the more frequent values were found to lie between 20 to 30 metres/sec.

If the movement of the irregularities is not uniform, the fading patterns obtained from spaced aerials are necessarily of random and dissimilar nature. In such cases the line-of-sight r.m.s. velocity of the irregularities was determined and was found to lie between zero and 4 metres/sec. The values obtained for the characteristic length of the irregularities and the spread of the angle of radio waves scattered from them are presented in the form of histograms. The average values of the characteristic length and the angular spread, however, are found to be 130 metres and 7 degrees respectively. It may be mentioned that the angular spread was also determined from the variation in the angle of arrival of the downcoming radio waves from the ionosphere and the results obtained by the two methods were in fairly good agreement.

2. Three-phase Transistorised Oscillator.

S. S. BANERJEE, A. B. BHATTACHARYA and S. K. CHATTOPADHYAYA,
Varanasi.

Three-phase oscillators generally suffer from the defect of generating more than one mode of oscillations as shown in one of our previous papers (Proc. Ind. Sci. Cong. Part III, 1960, p. 636). In the present communication the design of a symmetrical three-phase transistorised oscillator has been discussed which is capable

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of generating single frequency oscillations. The possibility of generating more than one mode of oscillations has been eliminated by the proper choice of coupling network between the transistor amplifier stages. It has been realised that the condition for the maintenance of oscillations and the expression for the frequency of oscillations can be easily obtained by matrix summation method. It has been shown that the three-phase oscillator presents a typical case where the matrix method of analysis in cascade type of oscillators can be employed with great advantage. The frequency term for the symmetrical three-phase oscillator has been found to depend on the collector load resistance and the effective capacitance between the collector and the ground terminals of each transistor in the oscillator. It was further found that the above effective capacitance limits the highest frequency that can be obtained with the help of such an oscillator. It has been incidentally observed that the maximum frequency generated by the oscillator can be conveniently used to determine the collector transition capacitance accurately under different operating conditions of the transistor.

3. Design of Transistorised Wattmeters.

S. S. BANERJEE, M. SENGUPTA and A. P. KULSHRESHTHA, Varanasi.

The property of non-linear operation of triodes and pentodes has been utilised by several investigators for the design of electronic wattmeters. Several improvements, however, have been found to be necessary in the design of such instruments as shown in some of our previous publications (Proc. 44th Ind. Sci. Cong., 1957, Part III, Abs., p. 469 and Jour. Sci. & Industr. Res. Vol. 20A 1961, p. 265). In view of developing portable type of such instrument the above principle has been extended to the design and construction of transistorised wattmeter which is found to be much superior to the conventional type of the electronic instrument particularly with respect to its accuracy, sensitivity, and simplicity of operation. In this instrument two transistors are used push-pull and operated non-linearly in the grounded emitter configuration. It may be mentioned that the grounded emitter configuration is preferred as it was found that several transistors in this configuration have a fairly wide squaring region in their transfer characteristics. The emitter ends are connected together to a high resistance which is connected to one end of the load, the other end of which is connected to a low resistance to provide a component of the load current for the input to the transistors. The range of the instrument can be changed by varying the high resistance in the input circuit of the two transistors. A d.c. microammeter as used in the conventional instrument is connected differentially across the collector circuit to record the power consumed by the load. The principle of operation of the above transistorised wattmeter has been explained by circuit analysis and the expressions for its sensitivity has been derived. The performance of the instrument has been compared with a standard electrodynamic wattmeter at power frequency and is found to be fairly satisfactory.

4. A comparative study of the performance of a Harmonic Generator with respect to Fractional sine wave. Isosceles Triangle wave and Rectangular wave, pulse drives.

K. S. PATEL and B. M. BANERJEE, Calcutta.

The full sine wave drive through a Class-C Harmonic Generator is limited at the most to the 4th or 5th order harmonics. The reason for this appears to be the

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inverse mode of decrease of the angle of plate current flow (α/τ) with the order of harmonic and that driving power increased very rapidly as (α/τ) becomes smaller.

The rectangular pulse drive, through a wide band circuit as proposed by the authors, however, does not suffer from these disadvantages and makes practical generation of the harmonics higher than the 5th. The performance of the generator is calculated out in terms of $(Cn)_{opt.}$, $(\alpha/\tau)_{n\ critical}$ and $(Aav)_n$ i.e. the values of the harmonic amplitude, angle of plate current flow, and the d-c value of plate current pulse, in the optimum case. The plot of $(Cn)_{opt.}$ vs. $(\alpha/\tau)_{n\ critical}$ for harmonics upto the 15th, shows a linear relationship, this is explained from the inverse mode of their decrease with the harmonic number.

The calculation extended to the case of Fractional sine wave and Isosceles Triangle, pulse drives shows similar relation between the parameters; besides, the ratio $\left[\frac{(C_n)_{opt.}}{(A_{av})_n}\right]$ remains sensibly constant and independent of the harmonics for the three types of pulse drives. The relative merits of each drive is brought out and explained. Full sine wave drive voltage for different (α/τ) ratio for the tube type QQE/06/40 is given for comparison.

5. Effect of Grid-Bias on the Noise Output of a Gas-Triode.

K. K. BOSE, Kharagpur.

One of the most common source of electrical noise is a gas discharge tube. In all electronic noise-generators either a gas-diode or a thyratron is used as noise source. In cases where thyratron is used the grid is generally connected to the anode of the tube so that the tube actually acts as a diode. It has been observed, however, that the control-grid of the thyratron which has normally no influence on the discharge current, can very effectively control the noise output of the tube. No reference of this phenomenon has been found anywhere by the author, but it confirms the suggestion made by Labrun and Bigg (Proc. Phys. Soc. Vol. 165, 1952) that the noise from a discharge tube is not of thermal origin. In the paper the experimental observations of the influence of the negative grid voltage on the overall noise output of the thyratron have been presented. The practical utilisation and application of this have been discussed.

6. Some effects of Bandwidth Limitation on P.S.M., P.L.M. and P.P.M. Signals.

J. DAS, Kharagpur.

A comparative study of the effects of bandwidth reduction on such important parameters as (i) sideband and harmonic distortions, (ii) crosstalk attenuation and (iii) signal-to-noise ratios, in case of p.s.m., p.l.m., and p.p.m. systems has been made. It is shown that the harmonic distortion in p.s.m. and p.l.m. are similar, whereas p.p.m. has no harmonic distortion. But the sideband distortion for large modulation indices is considerable in p.p.m. and p.l.m. only. The crosstalk attenuation is generally maximum in p.p.m. and for very narrow bandwidths p.s.m. shows improvement over p.l.m. The signal-to-noise ratios are also better in p.p.m. for average bandwidths but the p.s.m.—ratios improve when the bandwidth is very much restricted. Due to the absence of sideband distortion in p.s.m., the overall message grade in this system is found to be better than those in p.p.m. and p.l.m. for narrow-band working. For large bandwidths, however, p.p.m. gives the best grade of service.

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7. Study of the Behaviour Pattern of Nylon Sheathed Outdoor Cables for use in Tropical Climates

COLONEL B. M. CHAKRAVARTI, Bangalore.

The operating conditions encountered by field type of telephone cables which remain exposed to outdoors are rather severe in India. Cables for such applications should show stable electrical characteristics and a reasonably long life under severe tropical climatic conditions. These aspects could be realistially examined by exposing the cable specimens at the required operational areas for long periods. But, often, such long exposures are neither practicable nor acceptable. Designers prefer to find out the same information quickly by what are commonly known as the "accelerated" tests. However, at present, there are no universally accepted methods for estimating the actual outdoor behaviour and life of these cables by a laboratory process.

In this paper, the author has reported on his investigations on specimens of polyethylene insulated, nylon sheathed, field cables exposed to typical outdoor climates in India. The stability of the characteristics of the specimen under a laboratory simulated climatic sequence has been studied. An attempt has been made to establish a suitable laboratory test for determining their relative outdoor life.

For obtaining the actual outdoor life, the specimens were exposed at a field station near JODHPUR. The results obtained so far have been reported.

(2) DESIGN & PRODUCTION

8. Quality Control in Fan Industry.

S. CHAUDHURI, Calcutta.

The author gives a statistical quality control scheme as may be utilised in fan industry for better quality production at less cost operation. From the viewpoint of statistical quality control he gives the function of the different departments in this industry viz., (a) progress dept. (b) assembly dept. (c) manufacturing dept. (d) inspection dept. (e) development dept. (f) maintenance dept. and (g) quality control dept.

Quality control is an effective system for co-ordinating the quality maintenance and quality improvement efforts for the various groups in an organization so as to enable production at the most economical level which allow for full customers' satisfaction. Varying with the circumstances of each application from an over all quality control programme the following benefits may be expected.

(i) Improvement in product quality.
(ii) Improvement in product design.
(iii) Improvement in employee morale.
(iv) Improvement in amount of production.
(v) Reduction in operating cost.
(vi) Reduction in operating loss.
(vii) Reduction in production line bottle-neck.
(viii) Reduction in spoilage and rework.
(ix) Reduction in unnecessary Machine adjustments.
(x) Over-all saving in price and money.

The author discusses all these benefits in respect of fan industry.

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9. Optimisation of Squared off Cascade as applied to the process of Distillation.

D. GUPTA* and S. N. RAY*, Bombay.

Some generalised relations have been developed with all the necessary cost factors for the design of a distillation plant for the separation of stable isotopes based on the principles of Squared off Cascade. These relations are useful for the design of a plant for the enrichment of an isotope in the concentration ranges upto about 5 per cent. They have been used to design a water distillation plant for the enrichment of heavy water.

(3) METALLURGY

10. Underground Corrosion of Metals and Alloys under Indian conditions.

K. ROY, M. SARKAR and B. CHATTERJEE, Howrah.

Underground corrosion of mild steel (C, 0·28%; Mn, 0·91%ffi Si, 0·08%; P, 0·03% and S, 0·04%) and cast iron (C, 3·1%; Mn, 0·91%; Si, 2·09%; P, 0·24% and S, 0·12%) in four soils from Bangalore (red), Amraoti (black cotton), Bankura (laterite) and Berhampore (alluvial) has been studied by using the electrolytic corrosion cell of Denisiön-Schwerdt-feger type. The weight losses of corrosion cell electrodes made up of cast iron and mild steel and also the variation of the cell current with time have been measured. An attempt has also been made to correlate the soil corrosivity for mild steel and cast iron in relation to soil characteristics. The combined weight losses of the anodes and cathodes do not seem to show any correlation with the total soluble salt contents of the respective soils nor with the content of any individual component of the water soluble salt. A somewhat better correlation is observed between the combined weight losses of the electrodes of electrolytic corrosion cells on the one hand and the ratio of the total water-soluble anions, expressed as milli-equivalents per 100 gm. of soil, to the water holding capacities of the respective soil, on the other. With both types of electrodes the variation of the cell current with time is found to be dominated largely by chemical and physical characteristics of the soil.

(4) CERAMICS

11. Silicate Engineering : A Study of Iron Colours in Glasses.

H. N. DAS GUPTA and P. Sen, Banaras.

Investigations, aiming at obtaining additional fundamental knowledge relating to colouring effects of ferric iron in glasses at higher temperature, are in progress. The present communication, however, is an introduction to a series of investigations proposed to be undertaken. An attempt has been made at studying the differential thermal analysis characteristics of ferric oxide (250 mesh); comminuted glass of moderately high alkali content; and a mixture of this glass powder with a known p.c. of ferric oxide, and also to correlate if possible, the observed characteristics with available information on iron as a colourant for glass. A conventional type of D.T.A. set was used, the sample holder, however, was

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made from stainless steel. A heating rate of 5° per minute was maintained with a view to allowing sufficient time for changes, such as sintering; diffusion of ferric oxide; thermal reaction; phase changes, if any; etc., to take place. Endothermic and exothermic peaks have been noted in the curves so obtained.

From visual examination, the solidified Fe_2O_3 glass looked like a clear transparent mass with a yellowish colour and no trace of bluish or greenish tint could be detected. This fact, and the results of other tests, go to suggest the following :

(i) The rôle of absolute amount of iron on colour development appears to be of secondary importance.

(ii) The conditions inside the Fe_2O_3 glass did not help reduction of ferric oxide, although the glass was sufficiently alkaline. This observation is not in agreement with those of Moore (J. Soc. Glass Tech., 1949, *33*, 265-277), and Moore and Prasad (ibid, 1949, *33*, 336-760).

(iii) The bulk density of the iron containing glass changed, but the change was practically commensurate with the p.c. of ferric iron in it. This indicates that perhaps there has not been loss of any of the ingredients or of oxygen during fusion. Confirmation of this observation by other means is being done.

(iv) From the intensity of yellow colour developed in the glass, it appears that only a portion of the total ferric oxide is acting as a pigment. The prevailing conditions in glass, including duration of heating, were perhaps not favourable for the ferric iron to play the rôle of a network—former (Weyl, J. Soc. Glass Tech., 1943, *27*, 265). Indications have, however, been obtained that certain proportion of ferric iron has got access to the interstitial holes of the silica network as ions.

Further work in this line and with other colouring ions of Mn, Cr, Cu, V, Co, Ni, etc., is in progress.

12. Elimination of the Ceramic Reference from the Differential Thermal Analysis of Clays and Other Ceramic Materials. Part I.

D. K. PATWARDHAN, Banaras.

The substitution of the ceramic reference in place of the platinum one in the experimental set up of DTA of ceramic materials causes a reduction in the thermal response of the specimen, generates the BASELINE and makes it drift. The highly active surfaces of the ceramic reference absorb moisture. Such a reference renders the Tr axis nonlinear and makes for a reduction in size of the DTA-curve.

Elimination of the cause of all this confusion and its substitution by platinum, if necessary, are advocated.

13. Comparative Study of Crystal Growth in NephelineSyenite and Felspar Bodies, Part I.

V. C. JOSHI and M. L. MISRA, Banaras.

The formation of mullite crystals in porcelain bodies compounded with Nepheline syenite as addition at the expense of felspar and fabricated by different methods i.e. slip casting, dry pressing and plastic moulding are being investigated,

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14. Observations on High Temperature Ceramic yellow strains from Vanadium oxide.

H. N. ROY and V. C. JOSHI, Banaras.

Ceramic yellow stains for low temperature are usually prepared by calcining antimony oxide with lead oxide in an oxidising atmosphere. Antimony oxide alone does not give any colour. It is only when lead is present in the calcine or in the glaze the yellow colour can be produced.

Like antimony oxide, vanadium oxide also does not give a yellow colour alone. Vanadium oxide usually gives a grey colour in ordinary whiteware glazes, maturing at about 1160°C. Hence in order to develop the high temperature yellow ceramic colours, vanadium oxide requires zirconium oxide as a colouring medfa. Along with zirconium oxide, tin oxide, titanium oxide, iron oxide, aluminium oxide and silica can also be used in suitable proportions. The mixtures when calcined at 1200°C still retain some portion of the soluble vanadium oxide which has to be washed after grinding the calcined mixture.

In order to have the vanadium oxide in the combined form which will not be soluble, whiteware glaze and enamel frits were also made using very small proportion of vanadium oxide. Some of the glaze and enamel frits gave good yellow colour.

15. Refractory Materials from Bansi and EMLO (Their Properties and mineralogical nature).

M. L. MISRA, Banaras.

At Bansi in the Uttar Pradesh and at Emlo in Bihar occur two refractory materials of similar properties. These two materials are used in some of the factories in U.P. and Bihar in manufacture of refractory bricks. Their physical, chemical, pyrophysical properties and the results of X-ray study are given. It is suggested that these are not clays. They are probably the residual materials of under-clay calcined due to underground fire of old time coal fields and got mixed up with coal ash. Later on they got compacted due to pressure.

(5) CHEMICAL ENGINEERING

16. Utilisation of the Lime Sludge from the Water Softening Plants.

A. S. BHADURI, Bombay.

There are ten Lime-Soda Water Softening Plants in the Central Railway. The production of lime sludge, the ultimate reaction product of these plants, is about 40 tons a month. At present the sludge is considered as waste product only as there is no use for it either to the Railway or outside traders. In order to find out a suitable use of this sludge, disposal of which is rather a problem, works were taken up in the Central Railway Chemical and Metallurgical Laboratory. The chemical composition of the sludge shows that it contains more than 90% calcium carbonate and magnesium oxide. From this it is concluded that there are several possible uses of the sludge, which are as follows :

(a) Use as flux in the melting of cast iron in the cupola.
(b) Reclamation of the sludge by calcining and its reuse in the water softening plants.
(c) Manufacture of putty.

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The details of work carried out on these lines together with the findings are described in this paper.

17. Flotation of Low Grade Uranium Ore from Keruyadungri, S. Bihar.

T. R. MADHAVAN and K. K. MAJUMDAR, Bombay.

An uranium ore containing mainly uraninite in chlorite schist found at Keruyadungri, near Jamshedpur, Bihar, was subjected to flotation on a laboratory scale. The ore assayed 0·055% U_3O_8 and has the following mineralogical composition (in per cent) :—quartz 46, chlorite 37, apatite 3, tourmaline 3, opaque (viz. magnetite, ilmenite, sulphides, uraninite and pyrochlore) 7, others (hematite, limonite and zircon) 4.

The liberation size of uraninite being around 44 μ, it was thought that flotation may work better than gravity methods of beneficiation.

A number of flotation reagents were tried. Fatty acids and soaps were found to give good flotation for U_3O_8 values, in acid and near neutral pulp, oleic acid being the best. The effect of grinding time, conditioning period, pulp density, pH, activators, depressants and frothers has been studied. It is possible to get a U_3O_8 concentrate nearly three times the grade of feed (about 0·15% U_3O_8) with about 80% recovery under the following conditions : Oleic acid as frother-collector, 4·8 kg/tonne, Grinding time : 45 minutes, pulp density : 13% solids, conditioning period : 5 minutes pH about 4·6.

18. Electrolytic Cascade at Kangal.

D. GUPTA and P. G. DESHPANDE, Bombay.

The hydrogen distillation plant for the production of about 14·5 tons of Heavy Water per year will be commissioned very shortly at Nangal. The feed to this distillation plant is 5000 Nm^3 of hydrogen per hour. The deterium content in this hydrogen has been enriched to approximately three times the natural concentration in an Electrolytic Cascade. The principle on which the design of the Cascade is based has been discussed briefly in this paper. The Cascade relations have been developed first assuming ideal conditions. The actual Cascade relations with all the losses have then been developed the different combinations have been considered to find out the most conomic arrangement.

19. Evaluation of Fuller's Earth from Mudh, Rajasthan for decolourization of Lubricating Oils.

M. K. HASNUDDIN SIDDIQUI and D. S. DATAR, Hyderabad.

Raw Mudh earth exhibits capacity for bleaching lubricating oil which is enhanced on acid-activation. Activated earth also shows marked improvement in imparting thermal stability to the bleached oil. The performance of HCl-activated earth is somewhat better than that of H_2SO_4-activated earth.

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20. Fuller's earth from Korvi, Mysore, for reclamation of used lubricating oils.

ESHWAR RAJ SAXENA, D. S. DATAR and S. H. ZAHEER, Hyderabad.

Korvi fuller's earth was used successfully for reclamation of used lubricating oils from turbines, transformers and crank cases of trucks and railway and aero engines. The used oils are normally contaminated with oxidation products, dissolved water, acidity, carbon and fuel oil. The reclaimed oil is free from all these impurities.

21. Survey of Chemical Engineering Education in U.S.A.

P. S. LELE, Chandigarh.

A comprehensive survey of chemical engineering education in the U.S.A. was conducted with a view to obtain information suitable for organizing a new department for teaching Chemical Engineering at graduate and undergraduate level. Data was collected by visiting 25 representative universities. Three thousand three hundred and forty-two pages of typed matter, twelve books of solved problems, thirty four books on engineering education, ninety-six text books, one hundred and fifteen catalogues and photographs of chemical engineering laboratories have been collected. Some of the data is analysed. A summary of a diary of personal discussions with a number of Professors about problems connected with chemical engineering education is prepared.

(6) GENERAL

22. Training in Science of Materials.

N. K. PATWARDHAN, Roorkee.

Developments leading to the study of the Science of Materials as a distinct subject has been traced. The impact of solid state physics on the Science of Materials is great; a few examples of the work done on building materials in which certain phenomena are explained on Solid State Theory in Central Building Research Institute, Roorkee are given to indicate the scope of work.

In the end an attempt is made to indicate the places in the developed countries where training is being given on this subject and an appeal is made to our planners to give serious thought to starting such courses in India both at the post-graduate and under-graduate levels at the well established universities and colleges.

23. Time variation of cosmic ray intensity at 15° zenith at Gulmerg.

TAUSIF H. NAQVI and NIAZ AHMAD, Aligarh.

This systematic study of the daily variation of cosmic ray intensity has been done at Gulmerg at 15° zenith angle. Hourly counts have been recorded at 24 azimuth at an interval of 15° at the above noted constant zenith angle. A curve of counting rate versus the hours (Indian standard time) was plotted, the curve shows a maximum between 12 and 14 hours and two minima obtained in 24 hours, the first between 3 and 4 hours and the second between 19 and 20 hours. The maximum variation from the mean intensity was found to be about 1·5% which

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is in accordance with the results by other workers for vertical intensity. The meteorological effects have not been considered here due to no availability of the upper air data.

24. Use of retrowings in the landing of space ship.

SHIVA KISHORE, Jullunder.

In the landing of spaceship the problem is to dissipate the kinetic energy. One of the methods is the use of retrojet and the second is the use of air friction. The difficulty in the second method comes from the fact that the spaceship on approaching the planet moves with a velocity nearly equal to the escape velocity and at this velocity it can not be confined within the air as the centrifugal force is twice that of the gravity. The method of a series of dives through the air has been suggested to reduce velocity from the escape velocity to minimum orbital satellite velocity at which the spaceship can be confined in the air. In this paper the use of retrowing has been suggested to keep the spaceship within the air and bring about the landing by one continuous process. It has been suggested that the wings be adjustable from to retro to direct so that all the phases of landing can be covered. The retrowing thrusts the body towards the planet. The maximum thrust has been shown to be equal to the weight of the ship.

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CUTTACK–1962

PART IV

LATE ABSTRACTS

Section I, Mathematics

1. "On a new set of Postulates defining a field".

M. A. KAZIM, M. U. Aligarh.

G. Robinson has defined a field in terms of modern operation A.J.M. Vol. 59, pp. 385-392 (1937). The author here defines a field with 'right subtraction "$-$" and 'right division' : "$/$" as binary operations and proves that any arbitrary system $(F, -, /)$ satisfying the following postulates and definitions is a commutative field.

F_0 : $\exists$ at least two distinct elements in F

Def. 1 : $xy=x-y$. Def. 2 : $xx=o$ for any $x \varepsilon F$

Fs_1 : $xy \varepsilon F$ for $x, y \varepsilon F$

Def. 3 : $x^*=ox$

Fs_2 : $(xy^*)z=x(zy)$ for $x, y, z \varepsilon F$

Fs_3 : $xy=z \Rightarrow zy^*=x$

Def. 4 : $x+y=xy^*$

Fs_4 : $xy^*=yx^*$

FD_1 : $x/y \varepsilon F, y \neq o$

Def. 5 : $x/x=1 \varepsilon F \quad x \neq o \; 1 \neq o$

Def. 6 : $1/x=x', \; x \neq o$

FD_2 : For $x, y, z \varepsilon F$, $(x/y'./z=x/(z/y)$
where $y \pm o, \; z \neq o$

FD_3 : $x/y=z \langle = \rangle z/y'=x, \; y \neq o$

Def. 7 : (i) $xy=x/y', \; y \neq o$

FD_4 : $x/y'=y/x \quad x, \; y \neq o$

(ii) $xo=o$ otherwise

D.L I $(yz^*)/x'=(y/x') \quad (z/x')^* \qquad x \neq o$

D.L II $x/(yz^*)'=(x/y') \quad (x/z'^*, \; y \neq o, \; 3 \neq o, \; yz^* \neq o$

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Section II, Statistics

1. Solution of a Multiple-decision Problem with Two-stage Sampling.

JAYANTA KUMAR GHOSH, Calcutta.

The unknown mean Θ of a random variable x distributed normally with unit s.d., is $o, -\Delta$ or Δ. The possible terminal decisions, d_0, d_{-1}, d_1 are those of accepting H_0 ($\Theta=o$) or H_{-1} ($\Theta= -\Delta$) or H_1 ($\Theta= \Delta$). The loss is Wj if Hj is true but dj is not chosen, otherwise the loss is zero. The cost under Hj is Cj. The Bayes solution for a given a-priori distribution (g_{-1}, g_0, g_1) is studied. Since the case $W_{-1}=W_1=W>0$, $C_{-1}=C_1=0$, $C_0>0$, $gj=(1-g_0)/2$; $j=-1, 1$ is simple but brings out the main ideas; this case is considered first. The required extension is then made concisely. The result for the above simple case is described below.

An S-type rule T(A, B, C) were A, B, C are positive constants is defined as follows :—If $x_1>A$ accept H_1j; if $x_1<-A$ accept H_{-1}j; if $-B<x_1<B$ accept H_0j; otherwise observe x_2. At the second stage accept H_1 if $x_1+x_2>C$ accept H_1 if $x_1+x_2<-C$ accept H_0 if $-C<x_1+x_2<C$ (The decision boundaries belong to each of the two contiguous regions). It is shown that if the Bayes solution is to have the structure S then some conditions stated in the paper are necessary. Conversely these conditions are sufficient to determine the T (A, B, C) which is Bayes among S-type tests. It may be observed that these Bayes tests minimise the A.S.N. under H_0 among all tests with same or larger chances of making right decisions.

2. Probabilistic Investigation of a Single Server Queueing Process with Poissonian Input and Batch Service.

LAKSHMI VENKATARAMAN, Bombay.

This paper highlights some of the interesting methods employed by the author in the study of the above problem in her doctoral dissertation at Columbia University, New York.

Let τ_1, τ_2 $\cdots$ τ_η, ... be the instants at which the customers arrive at the counter. Then the interarrival times $\theta_n=\tau_n-\tau_{n-1}$ ($n=1, 2, \ldots$ $\tau_0=0$ are assumed to be independent and identically distributed random variable with distribution function

$$P\{\theta_n \leqslant X\} = \begin{cases} 1-\exp(-\lambda z) & \text{if } x \geqslant o. \\ o & \text{if } x<o \end{cases}$$

If the customer arrives at an instant when the server is idle, then his service starts immediately. Otherwise he waits in the queue from which the customers are served according to the following service mechanism. The "first come—first served" policy is used only to study the waiting time distribution. There is one server at the counter. A service period commences only when there is some customer waiting in the queue to be serviced. The customers are served in batches where the size of the batch equals min.(j. m) where j is the queue size of the start of the service period and m is a known constant. The service times x_n of the nth batch ($n=1, 2, \ldots$) are assumed to be identically distributed independent positive random variables with an arbitrary distribution function H(x3, and independent of the sequence $\{\tau_n\}$. Let τ_1', τ'_2, ..., τ_n, ... ($\tau_0'=o$) denote the instants of the successive departures.

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Define

$\xi(t)$ = the number of customers waiting in the queue or being served at the instant t.

$\xi_n = \xi(\tau'_n + o)$ = queue size immediately after the departure of the nth batch.

$\eta(t)$ = virtual waiting time at the instant t.

$\zeta(t)$ = number of people waiting to be served in the queue at the instant t.

η_n = wating time of the customer arriving last among those who are served in the nth batch.

The transient behaviour of the stochastic processes $\{\eta(t)\}$, $\{\xi(t)\}$ and $\{\zeta(t)\}$ and of the stochastic sequences $\{\eta_n\}$ and $\{\xi_n\}$ is investigated, from which the asymptotic behaviour of these processes is obtained by the theory of Markov chains and renewal theory. The stochastic law of the busy period and the distribution of the number of services in a busy period are also obtained.

3. On Certain Aspects of Asymmetrical Factorial Designs.

K. C. Raut *and* M. N. Das, New Delhi.

In recent times a good amount of work has been done to construct asymmetrical factorial designs. While constructing such designs usually care is taken to make the designs balanced. There is one more important requirement for such designs. They should be such that different affected main effects and interactions should be estimable mutually independently. If this is not satisfied, usually the error component for such designs cannot be obtained. A systematic method of investigating whether the affected interactions are estimable mutually independently through any particular design has been presented in the paper. An example to show that even though a design is balanced and the total loss of information is one less than the number of blocks per replication, the affected interactions cannot be estimated mutually independently through it, has also been given.

4. Recovery of Inter Block Information.

J. Roy *and* K. R. Shah, Calcutta.

The main problem in using inter block information for the purpose of estimating treatment effects consists in obtaining a suitable estimate of the ratio of inter-block variance to the intra-block variance. The method suggested by Yates and later on adopted by Rao makes use of the block sum of squares adjusted for treatments and of the error mean square in the ordinary analysis of variance. In this paper some alternative methods are suggested. The maximum likelihood estimates of all the parameters are obtained and an iterative procedure to arrive at these is also given. To derive the results an orthogonal transformation from the yields to uncorrelated inter and intra-block contrasts is used but the final computations do not involve the explicit use of this transformation.

5. On Simple Random Sampling with Replacement.

P. K. Pathak, Calcutta.

In simple random sampling with replacement, Basu (1958) and Des Raj and Khamis (1958) have shown that for estimating the population mean, the average

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of distinct units is more efficient than the overall sample mean. In this paper, a detailed treatment of the above problem is given; it is proved that the variance of the above estimator is given by :

$$V(\bar{y}_\nu) = \frac{1^{n-1}+2^{n-1}+\ldots+(N-1)^{n-1}}{N^n} S^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

where $\bar{y}_\nu$ is the average of distinct units in the sample, S^2 is the population variance, and n and N are sample and population sizes respectively. Several other estimators of the population mean are suggested and their relative efficiencies are compared. It is found that the above estimator has smaller variance than the well-known Horvitz-Thompson estimator if the coefficient of variation of the population is less than a given quantity and worse otherwise. Unbiased estimators of $V(\bar{y}_\nu)$ are given and their relative performance is studied with the help of a numerical example.

An improved estimator of the population variance is also derived. Lastly, a comparison between the two simple random sampling schemes (with and without replacement) is made for the purpose of estimating the population mean.

6. On the Necessary and Sufficient Assumptions for the Best Estimator in the theory of successive two stage sampling.

B. D. Tikkiwal, Dharwar.

The general theory of successive two-stage sampling has been studied by the author (Ann. Math. Stat., Vol. 29 (1958), pp. 1291). The best estimator on the hth occasion is obtained there under a specified correlation pattern, showing thereby that the assumptions regarding correlations on h ($h \geqslant 2$) occasions were sufficient for the best estimator of the form. It is shown here that if we want to have this form of the best estimator, it is necessary to have such assumptions regarding correlation of coefficients.

7. Use of Out-dated Frames in Large Scale Sampling Surveys.

K. C. Sela, Simla.

In planning a large scale sample survey it is often found that the available frame from which the sample could be drawn is not up-to-date. In a dynamic population the sample thus drawn does not, therefore, remain fully representative of the population existing during the period of the survey. Unless some adjustments are made on the data collected during the survey, estimate of any population characteristic would be somewhat biased. In this paper some simple methods have been suggested on the basis of a reasonable birth and death process (for taking into account of the changing population) which could be easily worked out in most of the practical situations. Some illustrations explaining the suggested methods have also been given.

8. Scrutiny of Working-sheets by Control Charts.

S. P. Mukherjee, Calcutta.

With manual tabulation, errors are likely to arise in the transcription of information on the questionnaire to the working sheet. To assess the accuracy, sample checks may be called for. In this paper an objective procedure has been

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suggested by which to judge from sample checks whether or not to examine an entire schedule for the case of m transcribes each working with a schedule containing k items of information for each of 1 units. The method consists in preparing a group control chart for fraction defective, each item being treated as a subgroup, the fraction defective being computed from a random sample of units. Varying numbers of units have been considered and the method extended to the case of a transcriber handling a number of questionnaires.

9. Statistical Evaluation of Pregnancy Wastage.

S. P. MUKHERJEE *and* D. BANERJEE, Calcutta.

Abortion rate as an indicator of wastage of pregnancy may be defined either for a cohort of mothers or for a cohort of pregnancies (or conceptions). The rate in current medical practice defined as the ratio of abortions to contemporary labour cases gives no estimate of the probability that a given conception will end in an abortion. For long-term calculations, end effects become negligible and the latter rate can be approximated by the ratio of abortions to all contemporaneous conceptions. While the former rate allows of a study of long-term trends, the latter is best suited to detect short-term (e.g. seasonal) variations. To derive the latter rate from the monthly totals of labour cases and abortions, one must introduce the concept of distributed lags between these two eventualities. Lacking data in respect of the gestation period prior to each abortion, lag regressions (for lags 3 to 8) may be used to estimate the 'exposure'. Exact and estimated rates have been computed from several hospitals in India for the quinquennium July 1954 to June 1959. This analysis however neglects intra-uterine foetal deaths.

Section III, Physics

1. More exact solution for non-local-potential in alpha-decay.

M. L. CHAUDHURY, Dhanbad.

It was shown recently (Chaudhury, Physical Review Letters, 5, 215, 1960) that the barrier penetrability for alpha-disintegration requires to be calculated by taking coulomb-field superposed by a non-local potential. The remarkable effect of the non-local part of the nuclear barrier on the penetrability has also been discussed there. However, the modified Shroedinger equation including an approximate delta function for the velocity-dependence and Igo potential for the static part leads to an equation which was solved by neglecting as small the first and second derivatives of the radial part of the eigenfunctions involved in the equation. Moreover, the equation was solved by the well-known W.K.B. method of approximation for mathematical simplicity.

In the present paper we have eliminated both these simplifications and have obtained more exact solutions by taking into consideration the part of the equation involving 1st and second derivatives (previously neglected) and instead of W.K.B. solution we have obtained solution in ttrms of spheroidal functions given by Meixner in a different context in his book.

The more exact eigenfunctions obtained lead to the same effect of non-locality for alpha-decay penetration. The detailed paper will be published elsewhere.

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2. Achromatisation of thin films.

Dr. V. Ramakrishna Rao *and* K. C. Mathur, Dehra Dun.

In the preparation of semireflecting optical components by the vacuum evaporation method, one disadvantage is the chromatic aberration of the transmitted and reflected light. The resultant colours are characteristic of the dielectric material used as well as the thickness of coating. It was found however possible to remove these colours and attain a neutral tint both in transmission and reflection.

Blanks coated with iron and oxidised suitably were found to have an orange yellow colour. When these were further coated with Magnesium Fluoride and Zinc Sulphide of suitable thicknesses (of the order of $\lambda/4$), neutral transmission and reflection could be obtained. It was also found that a neutral transmission and any specified reflected colour could be obtained by altering the thicknesses of MgF_2. In addition to thicknesses, the polarisation characteristics possibly explain the neutral tinge of the transmitted light. This kind of spectral contrast is of special requirement in some optical instruments.

Transmission and reflection coefficients of 50% and 30% respectively could be obtained with these specimens. These methods have the additional advantage of strong adhesion of the coatings to the substrate.

3. Seasonal variation of atmospheric ozone in India and some ozone-weather relationships.

S. Rangarajan, Karaikudi

An analysis is made of the total ozone amounts determined at the four regular ozone stations in India during the period 1958 to 1960. While the ozone content at Srinagar and Delhi is relatively higher during January-April, that at Kodaikanal is relatively higher during June-September. A very interesting feature of the ozone distribution in India is the reversal of the latitudinal gradient of total ozone during the monsoon season which leads to higher ozone in the south than in the north. A possible mechanism to account for this reversal is suggested in terms of seasonal variations in the tropopause height. Good correlations are observed between day-to-day fluctuations in the ozone at Srinagar and changes in the 500 mb contour heights at Delhi caused by the movement of disturbances in the westerlies. A case study of an abnormal increase of ozone in association with a western depression in March 1960 is also discussed. The increase of ozone is apparently caused more by vertical descent of stratospheric ozone-rich air than by adversion of northerly winds.

4. The "Optical Contact Method" for production of optical flats.

R. Hradaynath, Dehra Dun.

The use of optical flats satisfying the Rayleigh limit of image formation i.e. with surface accuracies of the order $\frac{h}{8}$ in a large number of precision instruments particularly of the interferometric type is well known, apart from its use in reflecting telescopes as diagonal mirrors. The present method of making optical flats is very much dependent on the skill of the worker and his ability to correct both his job and his polisher during the final stages. The procurement difficulties (apart from the cost involved) are so large that one is always deterred from trying out new designs in intergerometric instrumentation. In fact such difficulties in our laboratories led the author to try out a new

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production technique based on the 'optical contact method' and the use of optical tools of much larger diameter. This has resulted in a comparatively easy and accurate production of an otherwise highly skilled and laborious job. Optical flats, 60-80 media to an accuracy of 2/12 were produced and tested on an interferometer. Accuracy was further improved to h/25 by handworking.

5. Wave Shaping Circuit for use in Automatic Accompaniment.

H. V. Modak, Poona.

'Wave Shaping Circuit' has been developed for improving the working of the Automatic Musical Instrument invented by the author. The Automatic Musical Instrument is a string instrument which plays automatic accompaniment to vocal music. It works on the principle of resonance. Notes of vocal music are picked up by a microphone and the electrical variations are amplified. The amplified current is passed through the 'Wave Shaping Circuit' which gives either a saw-tooth or pulse wave shape to the vocal tone. The circuit changes vocal music into instrumental musical tones. Output current from the Wave Shaping Circuit is further amplified and is passed through a reed motor. Vibrations of the reed are communicated to a set of strings, tuned according to the notes of the musical scale used. When different notes are sung, the strings corresponding to these notes are set into vibrations in the same sequence, and thus the accompaniment is obtained. Accompaniment of the instrument is similar to that of bowed strings of the violin type.

Vibrations of the reed are also loosely coupled to the sounding board on which the strings are stretched. So when the notes are sung exactly in tune the corresponding strings and the sounding board vibrate, while for intermediate tones between any two tuned strings, the instrumental musical sound is emitted by the sounding board, thus maintaining the continuity of tones. Thus with the use of the wave shaping circuit additional strings for intermediate tones are not required. The paper describes the working of the Wave Shaping Circuit.

6. The specific Heat and Neutron Scattering from Graphite.

L. S. Kothari *and* J. Mahanty, Chandigarh.

In this paper an attempt is made to correlate the effect of the dispersion of the vibrational frequencies of the Graphite lattice with (a) the specific heat data, and (b) the cross section of inelastic scattering of cold neutrons from the lattice. A frequency distribution function having a logarithmic singularity is chosen, and the parameters are fixed by the specific heat data.

7. Anomalies in the Directional Intensity Pattern of Cosmic Radiation at 25° N Geomagnetic Latitude—II.

M. K. Khera, Gulmarg (Kashmir).

In continuation of the results reported last year in the Indian Science Congress on the presence of the fine structure in the zenithal intensity curves in the southern azimuth, further data have been collected in other principle azimuths and is being analysed. The data have been obtained with four-fold and three-fold coincidence telescopes having the apertures as $2° \times 33°$ and $2° \times 22{\cdot}5°$ in the east-west and north-south planes respectively. The preliminary analysis shows that the anomalies in the northern azimuth do not exist, outside the errors of the

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experiment, a result which differs from the earlier report made on the southern azimuth.

The data further reveal that a unique value of the exponent of the empirical relation, i.e., $N=I_0 \cos^n\Theta$, governing the zenithal intensity gives a good fit which is also contrary to the earlier results.

8. Ion-Free Radical Equilibrium in the (n, γ) Recoil Products.

H. J. Arnikar *and* A. Lal, Varanasi.

Results are reported for the relative proportion of free radicals and ions in equilibrium in the (n, γ) recoil products of bromine, the presence of ions of both signs in the recoil products having been established in our earlier work. Thermalised neutrons from a 300 mg. sourct of radium+beryllium were use for irradiating 500 ml. of bromobenzene (i) with and (ii) without an electric field of nearly 100 volts per cm. The changes in the relative concentrations of free radicals were studied by measuring corresponding changes in the magnetic susceptibility (ψ) by the Quincke's method employing a magnetic field of 4000 Oersteds.

The target material (C_6H_5Br) is diamagnetic, whilst the free radicals (Br and C_6H_5), and the ions (Br+ and Br−) add to the para and diamagnetism respectively. The observed changes in the liquid meniscus (a) −1·5, (b) −2·5 and (c) −0·3 mm. respectively for (a) unirradiated, (b) irradiated (without) and (c) with electric field, suggest an approximately 2 : 1 ratio for the ions to the free radicals. A possible mechanism is postulated for the corresponding secondary reactions following the (n, γ) recoil process.

Section IV, Chemistry

1. Turbidimetric method of determination of chloride in brackish water.

J. C. Chaudhuri *and* A. D. Purohit, Jodhpur.

A turbidimetric method of chloride in brackish water of Rajasthan has been described. The suspending medium for the AgCl is 1 : 1 glycerol containing 10% d-glucose (sp. gr. 1·180 at 15·5°c). Maximum concentration of chloride that can be directly dttermined by the method is 104 ppb as NaCl.

In aqueous solution, AgCl precipitates when the concentration of NaCl goes beyond 25 ppm. Consequently the aqueous solution can only be used below this limit for turbidimetric study. Highly concentrated solution e.g. the brackish water, would need large dilution if this method is to be used. For example, the salinity in brackish water varies over wide range, as experimentally found, in certain regions of Rajasthan between 500 to 10,000 ppm. The results show that for determination of 10^3 ppm of NaCl, no dilution is necessary and for NaCl of 10^4 ppm, only ten times dilution would be sufficient by the new method. If a sample of 10^4 ppm NaCl is to be determined by the aqueous solution method, the dilution required is greater than 400 and consequently the error will also be high.

Bausch and Lomb Spectronic 20 was used for these experiments. There is no optimum wavelength. 475 mμ was chosen for all experimentations.

A plot of chloride concentration (ppm) against percentage transmission gave a straight line, which can be expressed by an equation $y=61\text{-}0.5x$, that is, with a slope of $-\tan^{-1}\frac{1}{2}$. This standard curve enables one to read the ppm of chloride

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as given in the graph and the actual chloride concentration is found out by using the formula, derived in this connection namely,

$$Y = \frac{10\ A.X}{V}$$

where Y = Actual conc. of chloride as NaCl (ppm) in brackish water
A = No. of times of dilution that has been made of the original brackish water
X = ppm of chloride as NaCl read from the standard curve against percentage transmission
V = Volume of brackish water solution added to the glycerol-glucose solution.

The use of the above formula is involved because the volume of the glycerol-glucose solution together with the brackish water is kept constant viz. 10 c.c. and consequently the volume, V can vary. V, however, varies between 0·1 and 2 c.c. only depending on the concentration of chloride. Higher the concentration, lower is the volume, V.

Estimations have been made with NaCl, $MgCl_2$ $CaCl_2$ and with their mixtures Sulphates and nitrates do not interfere upto conc. of 500 ppm.

The method has been used for determining the salinity of a large number of brackish water samples of Rajasthan, having salinity between 500 to 10,000 ppm.

The results compare well with those obtained by Volhard method.

A large number of determination of chloride of brackish water can be done per day per analyst. The method will be useful where both speed and accuracy are needed.

Section V, Geology and Geography

1. The nature of the clay minerals in the Rajmahal-soils.

S. P. Chatterjee, R. Lahiri *and* R. Bhattacharyya, Calcutta.

The three major physiographic divisions of Rajmahal are : (1) The Gangetic Plain, (2) The Hills and (3) The Median Valley. The 'diera land' of the Gangetic (The Ganga) Plain has new alluvial or diara soil. Beyond the diara land,—towards Rajmahal (south of the Ganga) is a strip of land approximately bounded by the contour lines of 100 feet and 200 feet where the soil is the so-called 'old alluvium'. Along the northern slops of the Hills, facing the Ganga, there are three other soil types : (A) Lalmati (non-lateritic), (B) Karar, (C) Kewal, each having its own characteristic physical and chemical properties. In the Median valley, there are, again, three other soil types : (I) Lalmati (lateritic), (II) Bindimati, (III) Dhob ujjala. Of these, I & II are believed to be the exposures of the different horizons of an old laterite profile, whereas No. III is of sedimentary origin. The Balsundar is a light loam occurring in pockets near some of the hill streams.

The nature of the clay-minerals occurring in the weathering complex of the rocks which make up the clay fraction of the soils is of fundamental importance in pedological studies—both theoretical and applied. Considering this importance, the clay-minerals in the Rajmahal-soils have been studied from a chemical standpoint and the 'differential thermograms' of the clay-fraction of each of the above soil type have been given and discussed. Also, the approximate proportion in which the different clay minerals (kaolin, illite and montmorillonite) occur in each soilclay have been calculated,

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2. Geomorphological features of Pindari Glacier and its environs.

S. C. Bose, Calcutta.

During the various phases of Pliectocene glaciation Himalayan glaciers became very large and descended down to altitudes much lower than the present snouts. Climatic changes as well as the variations in altitude resulting from orogenesis were responsible for the advance of glaciers at various places. Pindari glacier is no exception. The Pindar valley today shows glacial features up to 20 kilometres below the present snout. A very great accumulation of old ground moraine and a large lateral moraine standing like a ridge, prove clearly the great magnitude of the past glacier. Recent observations confirm slow contraction.

3. The Naga Problem : A geopolitical Analysis.

R. N. P. Sinha, Patna.

The Naga problem of India represents a complex of many problems—the problem of tribal uprising, of cultural assimilation, of national cohesion, of territorial integration and of north-east frontier protection; all these arising from the peculiar physical environment which has moulded the human and economic geography of the region, and the spatial relationship which has made the area strategically significant.

Historically, Naga area was a component part of the vast Indian homeland even before the arrival of the Indo-Chinese tribal groups now known as the Nagas, but it is also a fact that the area was not fully controlled by the Indian rulers right from the past through the times of Mahabharat, Harsha, Ahoms, and the Muslims to the British.

The reasons are anthropogeographic. The rugged terrain, hot humid climate, soft soil, inhospitable forest cover and the resultant communication difficulties kept the area isolated and difficult to be subjugated. Ethnically and linguistically slightly different, the war-like Nagas kept their tribal culture intact and developed a war psychosis against any Indian rule.

Nevertheless, the Aryan cultural influence is reflected in the 'Mithan' sacrifice among the Ao Nagas similar to the Vedic 'Sheel-Gavya' sacrifice. During the British period they came into contact with the British administration and Christian missionaries who fostered in them a sense of being non-Indians and warned them of the so-called danger of 'Hinduisation', becoming more active on the eve of Indian independence. The partition of India, grant of special status to Kashmir and the activities of the Chins, Karen etc. in the neighbouring Burma might have been other motivations.

But in multi-racial, multi-lingual and secular India the demand for a separate State of Nagaland is meaningless. Being deficit in food and capital resources for modern development, the State will not be economically viable. And above all, the geostrategic conditions, especially in view of the Chinese eye on the NE frontier, compels India Government to control the area more effectively, but in co-operation with the Nagas.

4. The Naga Problem : A Geopolitical Analysis.

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environment which has moulded the human and economic geography of the region, and the spatial relationship, which has made the area strategically significant.

Politico-historically, though not fully integrated the area has always remained a component part of the Indian homeland, whether during the Mahabharat times before the arrival of the Tibeto-Burmese speaking Indo-Chinese tribes, the Nagas, during the beginning of the Christian era, or after, during Harsha, or the Ahoms or the British.

But the anthropo-geographic peculiarities have always worked against complete assimilation. The British administrators and Christian missionaries exploited the ethnic and cultural individualities of the Nagas and fanned their tribal and religious feeling against India, especially on the eve of their departure. Their cultural affinities with the Aryans reflected in some of their rituals such as the likeness of the Ao Nagas' 'Mithun sacrifice' to the Aryans' 'Sheel Gavya' sacrifice, were ignored. Difficult terrain, thick humid forest and consequent inaccessibility made the area ideal for guerilla activities. Acquisition of arms during the World War II, the formation of Pakistan, grant of special status to Kashmir and the agitation of Karens and Chins on the Burmese side of the frontier gave them further impetus.

However, the economic inviability and the strategic location of the area in relation to the neighbouring States suggest that the interests of the Nagas will be served best with India which is multi-lingual, multi-racial, secular and tolerant; and not in an independent Christian Nagaland.

5. Change in the Drainage Pattern in Middle Mountainous Country of Orissa.

DR. B. N. SINHA, I.I.T., Kharagpur.

The mountainous region of Orissa is a part of the Indian Peninsula with an initial slope from west to east, prior to the upliftment of the Eastern Ghats and the drainage channels were 'consequent' in type which followed the grain of the country. The old maturely disected surface along the Eastern coast of India stretching from Chota Nagpur Plateau upto Madras underwent a tectonic upliftment (upto 300 metres) subsequent to the Lower Gondwana deposits to the South West of Cuttack during the Permo-carboniferous period. All the major rivers of Orissa could maintain their west-east courses as they have cut through the 300 metres contour line.

This deeply eroded plateau along the rejuvenated long profile also underwent two other crustal upliftments which elevated the surface to 600 and 900 metres in two stages. This resulted in a sharp watershed in the heart of Orissa which beheaded the Budhabalanga, Subarnarekha, Rushikulya, the Vamsadhara, and the Nagavali but the Mahanadi and Brahmani could maintain their original west-east flow. The tributaries of Mahanadi like the Ib and the Tel and the Sankh and Koel of Brahmani came into existence on the western slopes of the Eastern Ghats with either South West—North East or North East—South West courses which captured the head waters of the beheaded rivers.

It appears that the upliftment of the Eastern Ghats was completed in three successive stages or there was a sufficiently longer interval between the last two upliftments.

This has been suggested by taking cross sections along the interfluves of the major rivers and at right angles to the present drainage channels. All the cross sections reveal the well developed accordant summit levels at 900, 600 and 300 metres. The beheading of the rivers can also be linked up with not only the elevations of their beheading but also with the stages of upliftment.

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A study of the mouths suggests their abnormally big sizes, compared to their present catchment areas and precipitation in case of beheaded rivers. If the main streams of the beheaded rivers are hypothetically projected in their upper reaches they roughly coincide with the general trend of the drainage pattern beyond the Western slopes of the Eastern Ghats.

Further work is essential for the final conclusion of the supposition. It has been suggested in the discussions that Geological studies are essential, either to prove or disprove the above proposition.

6. Relation of Atomic Constitution to Lattice Parameters in some Hornblendes from the Black Hills, South Dakota.

BIMALENDU RAYCHAUDHURI, Calcutta.

The study concerns six hornblendes separated from samples of amphibolite occurring as irregular masses enclosed in pelitic schists in which three zones of progressive metamorphism can be recognised. Two samples come from the lowest part, one from the upper middle part and two from the uppermost part of the garnet zone. The sixth sample comes from well within the staurolite cone. The complete wet chemical analyses and structural formulae calculated from the analyses, for the six hornblendes are given. All the hornblendes are classified as ferromagnesiohastingsite.

'a sin β', 'b' and 'c sin β' of each of the six hornblendes were determined from powder patterns using reflection (600) for 'a sin β', (0, 10, 0) for 'b' and (002) for 'c sin β'. The powder work was done with a Norelco geiger counter x-ray diffractometer; the experimental conditions and range of possible errors are discussed. Accepting certain reasonable assumptions, the data suggest that, qualitatively at least, substitution of Fe^{2+} for Mg^{2+} in the octahedral site and the substitution of Al^{3+} for si^{4+} in the tetrahedral site result in a regular increase in the size of 'a' and 'b' while 'c' is practically unaffected by these substitutions. The substitution of Al^{3+} for Mg^{2+} in the octahedral site probably causes a decrease in the size of 'b'. The results are similar to those found by H. H. Hess in his studies on orthopyroxenes of the Bushveld type.

Section VI, Botany

1. Inter-varietal variation in Chromosome pairing in cultivated roses.

M. L. SHAHARE, *and* S. V. S. SHASTRY, Delhi.

Determination of the chromosome numbers and the study of meiosis were undertaken in 96 varieties of cultivated roses. There is a regular bivalent formation in diploid varieties. In 56 tetraploid varieties of hybrid teas, a tendency for the formation of 14 bivalents was evident in 50 of them. The mean pairing in remaining 6 varieties is around 9-11 bivalents and 6-10 univalents. In 5 of these varieties, relation of univalent frequency with unequal bivalents was discussed. It was concluded that the cultivated roses are subjected to cromosome structural differentiation, and they differ greatly in meiotic behaviour. The main support for these univalents not owing their origin to differences in genomes of original parents is due to potentiality complete pairing in other varieties of the same origin, due to complete pairing at diploid level between the species involved in the origin of the hybrid teas, and because of their association with the occurrence of unequal bivalents.

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2. Natural and artificial tetraploids in the genus *Oryza*.

S. SAMPATH, Cuttack.

The genus *Oryza* has been inftrred to be of polyploid origin but the cultivated rice having the chromosome number 2n=24 can be treated as diploid. Some wild species, e.g. *O. latifolia, O. eichingeri* and *O. malampuzhensis* have the corresponding tetraploid chromosome number. The prevalence of tetraploids in nature is a challenge for the synthesis of fertile, cultivable tetraploid rices.

Autotetraploids of rice are easy to produce, are stable and show semisterility as well as increased sizes of spikelets. Due to low productivity, these cannot be used for cultivation. The factors controlling semisterility are inferred to be physiological, genic as well as chromosomal. Experiments are in progress to reduce sterility and to reduce frequency of quadrivalents in artificial tetraploids, by synthesis of allotetraploids, by selection and by use of ionising radiations.

The natural tetraploids are being studied for guidance in this project. The tetraploids *O. Latifolia, O. eichingeri* and *O. malampuzhensis* closely resemble the diploid species *O. officinalis* and have been shown to have one genome homologous with that of *O. officinalis*. These tetraploids do not show increase in spikelet size over the corresponding diploid. Detail of cytology, distribution and interrelationship of these species suggest experimental procedures for synthesizing fertile terraploid.

3. A Cytological approach to the cause of Triploid Sterility.

J. YANNEY—WILSON, Ghana.

The problem of high sterility in triploids is well-known since it is easily observed in practice. Most explanations of the cause have been genetical but a cytological follow up would be most welcome. But so far cytological observations have shown that in triploids the extra (*n*) chromosome complement per pollen mother cell is shared between the two daughter nuclei at Anaphase I in various proportions over and above the division of the basic diploid chromosome number. The movement of the chromosomes is at random so that when the daughter nuclei separate after Anaphase II the grains are produced with approximately binomial frequency distribution of the chromosome classes ranging from *n* to 2*n* chromosomes.

This has been studied in maize, *Solanum, Narcissus, Petunia* and tomatoes, and the data thus obtained only give the impression that the formation of a fertile triploid depends on the fusion between pollen and ovule of complementery chromosome numbers i.e. *n* to 2*n* or *n* 1 to 2*n*—1 etc. It is true that the chances of such complementary chromosome numbers mating are not terribly high, but they cannot account for the scale of sterility be observed in practice.

One way of looking for the answer to the problem lies in observations on the particular chromosomes which make up the chromosomes in the pollen grains and the ovules. But there are not many suitable species in which all the indiviual chromosomes can be distinguished, such as in *Crepis,* maize and *Aronyshila.* My recent studies of the Bluebell, *Endymion nonscriptes* (L) Garcke have added this to the above list of species with all the chromosomes distinguishable, and was used in the studies envisaged.

68 pollen grains were studied at Pollen mitosis I and all the chromosomes in each grain indentified.

One of the discoveries that emerged from this study was that some of the grains are not pure but either contain all of the 3 of a particular chromosome (triplicates), or have missing all the 3 of a particular chromosome (incomplete grains).

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The triplicates were more numerous than the complementary incomplete grains; —this supports the genetical idea that duplications are not as deleterious as deletions.

The satellitic chromosome was always present in each pollen grain at least once. This may mean that its absence may be deleterious.

Conclusions : The presence of impure grains decrease the chances of proper fertilization since these can lead to the formation of tetrasomic or nullisomic triploids. Further the chromosomes involved in 'triplicates' do not seem to have their complementary incomplete grains, and also the triplicates are far more numerous than the incomplete grains.

Hence the greatly reduced chances of the correct fertilization offer a true triploid, and the resultant sterility in triploids.

Ref. Cytologia 24 (4) 466-477. 1959.

Section VII, Zoology and Entomology

1. Normal Spermatogenetic cycle of Indian salientia.

J. L. Bhaduri, Asit Mondal *and* S. L. Basu, Calcutta.

Spermatogenetic cycle in Salientia is an ever fascinating problem in the field of reproductive physiology primarily due to its seasonal variation. Valuable reports have been obtained in the field of research involving particularly the frogs and toads inhabiting cold and temperate climates although there have been sporadic observations on the male gonadal cycle of tropical Salientia also. But in all these species except *Rana temporaria* neither any systematic observation throughout the year nor any quantitative evaluation on spermatogenesis has been made. Consequently, we tried in our laboratory with a precise and meticulous way, as mentioned above, to find out the annual male reproductive cycle of *Bufo melanostictus* and *Rana tigrina*.

For the sake of convenience, we have divided the whole process of spermatogenesis into six different stages starting form primary spermatogonia in the resting condition till the spermatid formation. Moreover, the stages were olso characterised by the number of cells in a cell-nest and by some specific cytological details.

In *Bufo melanostictus* there is almost a gradual and steady increase in the relative testicular weight from the month of September and reaches the maximum in the month of June. The tubule diameter is narrow and is more or less constant throughout the year. Primary and Secondary spermatogonial number increases from August till October—November and then a gradual decrease is noted. Advanced secondary spermatogonia and Primary spermatocyte are most frequent in the tubules all throughout the year. Spermatids are more frequent in the tubular lumen and they are predominant numerically from October through January. Sperms are present all throughout the year both in scattered and in bundled form.

In *Rana trigina* the relative testis weight and the mean seminiferous tubule diameter are directly proportional to each other. The increase in the testicular weight is noticed during January through May-June, and then a gradual decline is observed. The sperms and higher spermatogenetic stages are either few or absent during the winter months. It is interesting to note that the spermatogonia and spermatocytes generally predominate during winter months when spermatids sperms are absent (if present they are in a degenerating condition). But in summer all dividing stages of the spermatogenetic cell-nests are present. As soon as the temperature decreases further progress of sperm formation is checked.

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Form the previous reports various types of spermatogenetic cycle in Salientia may be grouped into three categories, e.g., CONTINUOUS, POTENTIALLY CONTINUOUS, and DISCONTINUOUS types. Thus from the above observation it appears that the annual cycle of *Bufo melanostictus* is a continuous one while that of *Rana tigrina* is potentially continuous.

2. Effects of Testosterone on the Spermatogenesis of frogs.

S. L. BASU, Calcutta.

Several investigators have tried to elucidate the effects of testosterone on the male gametogenesis in some higher vertebrates. But our knowledge is utterly inadequate at present about the testostrone—spermatogenesis correlation in Salientia. During last few years some reports appeared regarding this steroid action on the spermatogenesis of *Rana temporaria* (van Oordt and Basu, 1959, 1960) and *Rana esculenta* (van Oordt and Schouten, 1961) of Europe. In both the above mentioned species it is conclusively proved that testosterone appears to cause complete inhibition of the multiplication division of the spermatogonia and thus prevents the strong increase in spermatogenetic activity.

With a view to compare the testosterone action on the spermatogenesis of temperate ond tropical Salientia, a group of common Indian frogs, *Rana tigrina* was treated with testosterone in the form of hypodermic pellets during last summer with adequate controls. It is observed that within four (4) weeks time a complete inhibition of the spermatogenetic activity takes place. Moreover, the histoarchitecture of the treated and control testes of *Rana tigrina* further reveals that the action of testosterone in this tropical frog with potentially continuous spermatogenesis is more intense within this short span of treated period. The results obtained in the present experimental material is compared with other species of frogs of the temperate zone. The mode of action of testostedone and its probable role in the regulation of the spermatogenetic cycle is also discussed.

3. On the breeding of major Indian carps by the injection of pituitary gland hormone.

J. C. ROY, *and* R. K. DAS, Orissa.

1. Thirty sets of experiments were conducted on the breeding of *Cirrhina mrigala, Labeo rohita* and *L. calabasu* by the injection of Pituitary gland hormone of catfishes, major carps and mullets at Kausalyaganga, Balasore, Kathpal, Sambalpur and Sonepur.

2. In 25 sets of experiments which were successful, 16 experiments were with catfish glands with a percentage of hatching between 10 and 90, 9 experiments were with carp gland, with a percentage of hatching between 50 and 99.

3. Single injection led to breeding in 6 cases, double injection in 16 cases and triple injection in 3 cases.

4. Breeding took place between water temperature of 26·8°C to 29°C but only in one case it occurred at 30°C.

5. In 3 sets where there was no spawning, the water temperature was 30°C and above. In another case, spawning did not take place, possibly as the breeder was not ripe Mullet pituitary gland, preserved for 9 months having been administered in another sent, did not result in spawning.

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4. On the vocal sounds of snakes.

B. K. Behura, Cuttack.

The hissing sound of snakes is a respiratory act. In the cobra, the throat is turned into a sort of pouch and the sound 'fohn' is produced both during inspiration and expiration. In the bull-snake (*Pituphis*) of North America which produce a loud hissing sound, the air strikes against a fleshy flap rising in front of the opening to the wind pipe. Hissing is usually combined with the inflating and flattening of the body. A review of the few recorded cases of snakes producing sound other than hissing is made. The pythons (*Python molurus*) and the dhamans (*Ptyas mucosus*) under duress or when alarmed produce sound which resembles a long drawn out 'oomh' of a child disturbed at play or of a man in agony. The banded krait (*Bungarus fasciatus*), the dhaman and the *Boodon lineatus* of Sudan produce various kinds of sounds other than hissing and 'oomhing'.

5. Studies on the arterial system of the common Indian toad, *Bufo melanostictus* Schneider. 1. The occipitovertebral artery.

Priyambada Mohanty, Cuttack.

In the common toad, *Bufo melanostictus* Schneider, the occipito-vertebral arises near the subclavian artery from the inner border of the systemic arch. It runs forwards giving rise to a *pharyngeal* artery supplying the pharynx and continues anteriorly close to the internal carotid artery. It gives out a small *muscular* artery supplying the muscles of the dorsal side. It then penetrates the dorsal muscles and bifurcates into two, a *vertebral* artery running at right angles to the other, the *occipital* artery. The vertebral artery enters the vertebral column. The occipital artery continues to run dorsally and emerges out posterolateral to the cranium and the occipital region. The occipital continues along the outer edge of the fronto-parietal of the side and gives out an *optic* artery which supplies the orbit and the eye. The occipital artery continues further anteriorly, then bifurcates into two, the *olfactory* artery entering the nasal sac and the *cranial* artery entering the brain at its anterior end.

6. An analysis of the food of the Grey Quail (*Coturnix coturnix* Linnaeus) of Western Rajasthan (India).

Ajit Kumar Mukherjee, Calcutta.

The present paper deals with the results of investigation about the food habits of the grey Quail, (*Coturnix coturnix* (Linnaeus) in Western Rajasthan. The author analysed the gut contents of 21 specimens collected from Nagpur, Jodhpur and Jaisalmer Districts during the winter, spring and summer of 1957 to 1960. Most of the birds were collected from near-about cultivated fields of millets.

The analysis revealed that the birds are more or less dependent on vegetable matter (approximately 90 percent) of which about 72 percent consists of tender leaves, flower buds and weed seeds of mostly wild grasses only, and 18 percent of seeds of cultivated grains. The animal food is about 8 percent composed of spiders and some insects of agriculture importance. In conclusion the bird could hardly be accused, at least in Western Rajasthan, to be economically harmful against the general belief that it robs seed grains, oil seeds and pulses from standing crop and farms.

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Section VIII, Anthropology and Archaeology

1. Notes on the method of studying rural society.

SURAJ BANDYOPADHYAY *and* KUMARANANDA CHATTOPADHYAY, Calcutta.

1. This study is concerned with how to derive a normative picture of any rural society as a whole. It is divided into three parts, viz. (a) the method, (b) the frame-work and (c) an illustration from the analyses of 439 villages having 26,173 households and a population of 1,44,951 surrounding Giridih Town in the district of Hazaribagh, Behar.

2. The study advocates a particular method termed here as "homogeneity method" which if followed seems to minimise the survey units in order to curtail the all-round cost of the same without sacrificing any important data in this respect.

3. In the frame-work, the writers have chosen six different societal attributes for determining the homogeneity of villages. These are (1) Community, (2) Religion, (3) Caste structure, (4) Industry, (5) Occupation and (6) Location or place of work of rural folks.

4. The next part of the study deals with the analyses and distribution of several hundred villages of a particular area under three physical attributes, namely, (i) Town distance, (ii) Bus distance and (iii) village size.

5. In the concluding portion the writers have shown the importance of physical attributes for isolating the homogeneous villages in order to facilitate the above mentioned study. They have also stressed that, as the present study is an exploratory nature in the sense that it is restricted to a particular area, so no rigorous inference should be drawn from this study. They hope, however, that other scientists will apply this method to their respective fields and will thereby help in arriving at a scientific generalization in this regard.

2. The Incubus of Ethnic Evolution and its impact on National and International Integration.

JAL F. BULSARA, Bombay.

In the world as we find it to-day, there are 90 nations who are members of the United Nations Organisation, and there are about ten nations who have not been admitted to the U.N.O. for various reasons. There are more who are under colonial rule. Hardly five of these form single or unmixed ethnic or linguistic groups. Among the smallest nations, there are, inter alia, dialectical, ethnic, or tribal groups, who claim individual existence or special facilities and privileges. A few countries like Switzerland and the United Kingdom have succeeded in stabilising their internal minority group relations, but a majority of the nations of the world cannot be said to have done so. Friction wells up among them periodically and is an obstacle to unity of action towards progressive national development. The object of the Paper is to probe into the formative factors of ethnic evolution and to study the historical causes of group antagonisms, with a view to see how they could be removed or obviated as obstacles to national unity and international cooperation.

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Section IX, Medical and Veterinary Sciences

1. A case of Chronic Seborrhoea treated with tissue therapy.

D. K. Ray, Calcutta-37.

Tissue therapy was tried with success in a case of chronic seborrhoea with corrugated hyper keratosis of skin in an old man aged 50. Course of 30 injections of tissue extract was given daily. Progressive improvement was noticed throughout the course of treatment. The affected areas looked absolutely normal one month after the course of treatment was over.

2. The amino acid composition of Trichomonad Protozoa.

Krishna N. Mehra, Nainital.

Paper electrophoretic studies of the hydrolysates of *Tritrichomonas foetus, Tritrichomonas suis, Trichomonas gallinarum, Trichomonas gallinae, Trichomonas hominis* and *Paratrichomonas* sp. from pig rectum revealed the presence in all species of aspartic acid, glutamic acid, arginine and/or lysine. One band which migrated relatively little might have contained several amino acids. An unidentified band which migrated beyond the fastest basic amino acid was also present. In an unhydrolyzed *T. foetus* extract, glutamic acid and arginine and/or lysine, two bands similar to those in the hydrolysate, were identified. Unidimensional paper electrophoresis was not found to be a satisfactory method for the separation of amino acids. The electrophoretic patterns of the 6 species studies looked the same and it was not possible to distinguish one species from another.

Aspartic acid, threonine, serine, glutamic acid, glycine, alanine, valine, isoleucine, leucine, tyrosine, phenylalanine, histidine, lysine and arginine were found and their amounts determined by column chromatography in the hydrolysates of *T. foetus, T. suis, T. gallinarum, T. gallinae* and *Paratrichomonas* sp. Aspartic and glutamic acids were highest in amount in all species. The lowest in all species was histidine. Proline was present in all species but in an amount too small to be studied quantitatively. An unidentified compound which emerged from the column later than arginine was found in all species. In addition to the above amino acids, cystine, cysteine and methionine may have also been present in amounts too small to be detected. There were some differences in the quantities of different amino acids in the various species, and it is possible that trichomonad species may be identified on the basis of the amounts of amino acids which they contain.

3. Avian Salmonellosis: An outbreak of egg-peritonitis simulating *Salmonella Pullorum* infection caused by *Salmonella Stanley*.

S. S. Khera, S. B. V. Rao *and* K. K. Agarwal, Mukteswar-Kumaon.

An outbreak of avian salmonellosis caused by *Salmonella stanley* is described. In the laying birds which were chiefly affected, the disease was characterised by necrotic lesions in the ovaries. The lesions often progressed to generalised peritonitis. *S. stanley* was invariably isolated from the lesions of affected birds. The treatment of birds with certain drugs of proven efficiency such as Nitofurazone and Furazolidone was of no avail and the disease was controlled by segregation and destruction of serological reactors, and immunisation of other birds with a vaccine prepared from the isolated strain of salmonella.

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4. Studies on (a) pathogenesis of *Brucella Abortus* infection in Guinea Pigs. (b) pathological changes in the lymphoid organs and correlation of serological response with the plasmocytic reaction.

P. RAMA RAO, S. S. KHERA *and* G. L. SHARMA, Muketswar-Kumaon, U.P.

Clinical observations and the progress of pathological changes in the spleen and lymph nodes of 40 *Br. abortus* infected guinea pigs sacrificed at different post-infection intervals have been described.

The infected animals had shown a mild low grade temperature reaction, low weight gains and gradual loss of condition. Microscopic changes, apart from characteristic surface granulation seen in the spleen from 16th day onwards, were negligible. The microscopic changes in the spleen which were most pronounced on 20th and 24th days, were characterised by lymphoid hyperplasia and necrotic changes in the lymphoid follicles, reticular hyperplasia in the splenic cords, cellular engorgement of sinuses, epithelioid and giant cell formation both in the white and red pulp and formation of abscesses occasionally. In the lymph node the changes were essentially similar to those observed in the spleen but tended to develop later and were relatively more pronounced.

A close correlation was observed between the serum agglutinin titre and the plasma cell reaction in the lymph node throughout the course of infection.

5. Studies on (a) pathogenesis of *Brucella Abortus* infection in Guinea Pigs. (b) the distribution of Brucellae in the body tissues after intravenous inoculation.

P. RAMA RAO, S. S. KHERA *and* G. L. SHARMA, Muketswar-Kumaon, U.P.

After intravenous inoculation of $9{\cdot}08\times10^8$ organisms of *Br. abortus* strain 544 in male and pregnant female guinea pigs, it was found that the primary bacteraemia lasted for about 48 hours and the blood was not infective on the 4th day. During first few hours the number of organisms gradually increased in the spleen, lymph nodes, liver, lungs, kidneys and testis or uterus. Although the infection was sustained in all of the organs tested, except kidneys, up to the study period of 35 days, progressive increase in the number of organisms occurred only in the lymph nodes and testis in males and uterus in females. Secondary bacteraemia occurred about the 20th day.

6. Studies on pathogenesis of *Brucella Abortus* infection in Guinea Pigs. and pathological changes in the uterus, testis and some other organs.

P. RAMA RAO, S. S. KHERA *and* G. L. SHARMA, Muketswar-Kumaon, U.P.

The progress of *Br. abortus* infection was followed in forty guinea pigs which were killed at intervals of time upto 56th day.

In the pregnant females the congestion of maternal sinuses and placenta was followed by inflammatory and suppurative necrotic changes in the maternal decidua and junctional zone of trophoblast. Secondary abscesses were seen in the labyrinth on 24th and 35th days of infection.

In the non-pregnant animals the uterine wall showed pronounced leucocytic infiltration particularly around the uterine glands many of which contained suppurative exudate. Small microscopic abscesses were seen in the myometrium occasionally.

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In the males, in the testis degenerative changes in the seminiferous tubules were most pronounced on 12th and 16th days. Abscess formation was encountered only occasionally in the epididymis but never in the testis.

In the liver leucocytic infiltration in the portal areas and in the lobules was noticeable from 4th day onwards. After the 8th day changes were characterised by granuloma formation in the portal areas and small necrotic foci in the parenchyma which involved both Kupffer cells and the hepatic cells.

In the lungs thickening of lobular and alveolar septa owing to the proliferation of septal cells and infiltration of mononuclears was most pronounced about the 35th day of infection.

In the kidney and adrenal the changes were relatively mild and retrogressive. In the kidney the tubular cells both in the cortex and medulla showed degenerative changes. In some animals renal corpuscles showed thickening of Bowman's capsule and disintegration of glomeruli. In the adrenal mild degenerative changes in the cortical cells were accompanied with diffuse mononuclear infiltration.

7. Studies on post partum oestrus in Murrah buffaloes.

S. N. Luktuke *and* D. J. Roy, Izatnagar, U.P.

Studies have been conducted on post partum oestruses in buffaloes belonging to the experimental Murrah buffalo herd of the Indian Veterinary Research Institute, Izatnagar.

It was found from 123 post partum periods that the first oestrus appeared on an average 115·58±7·10 days following parturition. The interval between parturition and conception was found to be 149·36±7·40 days. The first post partum oestrus was not always ovular. The incidence of anovular oestrus was found to be 5·7 per cent. In 18 cases the corpus luteum was detected though the animals had not showed any signs of oestrus post partum. The incidence of silent oestrus worked out to be 14·6 per cent. The intensity of heat at first post partum oestrus was normal in 80·0 per cent, weak in 18·1 per cent and pronounced only in 1·9 per cent cases. Inseminations were done at the first post partum oestrus in 105 cases out of which 62 (59·0 per cent) conceived. Animals which repeated were inseminated at subsequent heats. Overall pregnancy rate worked out to be 1·60 A.I./conception.

8. Relative efficacy of different buffers for the preservation of buffalo semen.

U. D. Sharma *and* S. C. Mahajan, Izatnagar, U.P.

The experiment was designed to assess the comparative efficiency of some of the most commonly employed semen diluents namely, yolk-phosphate, yolk-citrate, yolk-boiled milk, yolk-glycine and yolk-glucose-bicarbonate dilutors. 12 semen samples from nine buffalo bulls were diluted at 1 :10 and 1 :50 levels of dilution. Yolk-glucose-bicarbonate diluent was found to be significantly superior to the other diluents compared in this experiment. The average number of days, the sperm survived in this diluent were 16 and 12 days at dilution rates of 1 :10 and 1 :50. The average number of spermatozoa surviving after 10 days of storage were 22 and 8 per cent at low and high dilution levels respectively. From the results of this investigation, it is concluded that buffalo sperm can possibly be preserved in yolk-glucose-bicarbonate diluent for at least 3-4 days with desired motility rating for A.I. use provided the dilution rate of semen is not high. At higher levels of dilution, agents effective against harmful effects of dilution should be incorporated.

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9. Preservation of buffalo semen. III. Role of seminal plasma IV. Effect of potassium ions in yolk-glucose-bicarbonate diluent.

U. D. SHARMA *and* S. C. MAHAJAN, Izatnagar, U.P.

Preservation of semen from buffalo bulls of 'local type' revealed that :

(i) Centrifugation of buffalo semen was harmful for the subsequent preservation of spermatozoa.

(ii) The addition of seminal plasma to the centrifuged semen helped in part to overcome the harmful effect of centrifugation.

(iii) There was an indication that the addition of five parts of isotonic KCl solution (1·15 per cent) to 95 parts of glucose-bicarbonate buffer had some beneficial effect against dilution on preservability of buffalo spermatozoa.

(iv) Potassium bicarbonate buffer was superior to sodium bicarbonate buffer but the differences failed to be significant.

10. Some observations on preservation of buffalo semen in the Illini Variable Temperature diluent.

U. D. SHARMA *and* S. C. MAHAJAN, Izatnagar, U.P.

The preservation of semen from three buffalo bulls in the Illini Variable Temperature (I.V.T.) diluent showed that the spermatozoa survived better in an air-conditioned room (22-30°C) than at room temperature (18-30°C) or in a refrigerator (4-6°C). At room temperature (18-29°C) spermatozoa survived better in I.V.T. diluent containing ten per cent egg yolk than in the diluent with no egg yolk. There was special advantage in using sulphamezathine instead of sulphanilamide in the I.V.T. diluent at room temperature.

11. Cases of seborrhoea with secondary infections in Children cured with Tissue Therapy.

D. K. RAY, Calcutta.

Six cases of seborrhoea with secondary infections in children was tried with tissue therapy with success. Water extract made from treated Neem leaves was administered orally for 25 days to get a full recovery. It is nearly a year now and recurrence does not seem to have occurred.

12. Lepromatous Leprosy treated with Tissue Therapy.

D. K. RAY, Calcutta.

Tissue therapy was tried for the first time in the cases of Lepromatous type of leprosy in human beings. Considerable bacteriological improvement was noticed after the 18th injection. Further improvement was noticed after 30th injection in the reduction in number of bacilli per field as well as in the number of globus forms in the major part of the smear. Trial is now on in the same patient with tissue implantation (Ray, 1960) as well as a course of tissue extract injection.

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13. Tissue therapy in a case of Maculoanaesthetic type of leprosy with Trophic Ulcers.

D. K. Ray, Calcutta.

Implantation of skin of heterogenous origin followed by a course of Tissue extract injection is being tried in a case of Maculoanaesthetic type of leprosy with tropic ulcers in a woman aged about 35. Result obtained so far is very encouraging. Trophic ulcers have completely healed up with 25 injections given on alternate days. The patient has a feeling of general well being and rapidly improving in health. A total of 45 injections will be given in the first course. The treatment may have to be repeated after some months and three such courses have to be given before anything definite could be said about the efficiency of this therapy in leprosy of this type.

Section X, Agricultural Sciences

1. Experiment on Polyethylene Mulching.

K. Sengupta *and* M. K. Das, Kalyani.

Polyethylene film has been widely used for agricultural purpose in U.S.A. and other countries over last few years.

The black Polyethylene film is well suited for mulching purpose. It is flexible and can be spread over the ground. During the rainy season, it prevents rains from compacting the soil. It also prevents evaporation of moisture from soil. Since evaporation of moisture is prevented to a great extent, crop can be raised with fewer number of irrigations. The black film also prevents weed growth and therefore, the cost of weeding is reduced to a great extent.

An experiment was conducted at the Seed Multiplication Farm, Fulia to find out the effect of Polyethylene mulching on the yield of Cauliflower. Treatments were (i) Control, (ii) Planting on flat bed and immediately mulching with Polyethylene and earthing up after three weeks, (iii) Planting on ridges and immediately mulching with Polyethylene—earthing up after three weeks. The yields obtained were 200 mds per acre for control, 312 mds. per acre under treatment (ii) and 355 mds. per acre under treatment (iii).

Experiments are also under operation on crops like Brinjal, Jute and Maize.

2. Studies on Liming of Acidic Red Loam Soils I.—Response of Crops to Liming.

S. C. Mandal, H. Sinha, C. R. Prasad *and* M. A. Ali, Ranchi.

Acid soils are found extensively in six out of seventeen districts of Bihar, covering four to five million acres. A precarious crop of paddy is grown in these soils, interspersed with the millet crops *marua* and *gondli* and the pulse crop *rahar*. These acid soils are of poor fertility with low contents of calcium, nitrogen, phosphorus and organic matter. They respond to fertilisers and the yield of paddy can be pushed up from 3 to 5 mds./acre to 7 to 8 mds./acre only. Upland crops e.g. maize, *juar*, cotton, soyabean, *mung*, groundnut etc., fail to grow well and yield a reasonable quantity even after normal supply of N, P, K fertilisers to the soil. Acidity being the principal limitation of the productivity of these soils, a series of experiments with lime were conducted at Kanke farm during the years 1958-61 in two plots of soil reaction pH 5·3 and pH 5·4 respectively. A number of crops were grown viz., maize, *juar*, soyabean, *rahar*, ground-

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nut, cotton, *kalai* (*Phaseolus mungo*), *mung, marua, gondli, surguja* (niger), wheat, barley, pea, gram, *masur* (lentil), mustard and linseed. Paddy was not grown as it failed to respond to lime in a pilot experiment conducted during the years 1956-58. Lime was applied according to the lime requirement of the soils, worked out by laboratory equilibrium methods. The increase in yield due to liming varied from 100% in maize and juar to 1000% in rahar. Crops that respond highly to lime, or the most calciphilic crops, are *rahar,* cotton, soyabean, gram and groundnut. The crops of intermediate lime response, or calciphilism, are maize, *juar, kulthi, kalai,* wheat, pea and *masur.* Crops that show little or no response to lime are paddy, *marua, gondli, surguja,* barley and mustard. Cropping should thus be adjusted according to the lime status of the soil. Calciphilic crops should be grown in the early years of liming followed by crops of intermediate calciphilism and the non-responsive crops in the last one or two years in a cycle of five or six years.

3. Studies on liming of acidic red loam soils II.—Dose and Frequency of Liming.

H. SINHA, P. SINHA, M. A. ALI *and* S. C. MANDAL, Ranchi.

It has been discussed in an earlier paper of this series that application of lime to the acidic red loam soil of Chotanagpur led to great increases in the yields of a number of upland crops. Concurrently, field and laboratory studies were also undertaken to determine the dose and frequency of liming in these soils. Field experiments indicated that for pH 5·7 one ton of lime would be required in lighter soils. Lower doses are not effective as much and higher doses bring about no additional increases in yields. On the basis of laboratory equilibrium studies and those field experiments a tentative schedule for liming has been worked out for three textural classes sandy loam, loam and clay loam. It has been found that for each difference of 0·1 unit of pH the lime requirement changes by about 400 lbs. of lime per acre. Field experiments on the frequency of lime application conducted for five years, proved conclusively that lime should be applied once in five years to the full lime requirement dose of the soil. There is no additional gain in applying lime every season or every year.

4. Studies on liming of acidic red loam soils III.—Placement of Lime.

S. C. MANDAL, H. SINHA, C. R. PRASAD *and* M. A. ALI, Ranchi.

Placement of fertilisers has engaged the attention of agronomists for a long time. It has also been found by some workers, particularly of Australia, that deep placement of lime is more effective than surface application. An experiment was thus laid out in the acid soil of Kanke farm (pH 5·3 to 5·4) to find out if depth placement or surface-cum-depth placement is more effective than surface application. Gram and maize were grown as experimental crops for three successive years. No beneficial result was obtained from depth placement or depth-cum-surface applications of lime.

5. Studies on liming of acidic red loam soils IV.—The quality and fineness of liming materials.

S. C. MANDAL, H. SINHA, C. R. PRASAD *and* S. C. LALA, Ranchi.

Field experiments were conducted on a soil low in almost all the major elements and representing a typical upland red loam of Chotanagpur to study the

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effects of quality and fineness of liming materials on the yields of maize. Results of the experiment show that all the liming materials were equally effective in increasing the yield of maize. Though the highest increase in yield was obtained with market lime, it was not significantly different from the yields obtained by the application of limestones collected from different sources.

The degree of fineness of liming materials also did not influence the yield of maize. The coarse particles of limestone representing 10 mesh size raised the yield of maize to the same extent as finer particles of 100 mesh size.

Definite conclusions, however, cannot be drawn from one year's experimental results as presented here. The study will continue for two more years. Nevertheless, it is apparent from the existing data that the quality and fineness of liming material have no significant effect on the yield if applied in accordance with the total calcium requirement of the soil.

6. A suggestion as an alternative to the usual Polariscope one in evaluating cane types from sugar point of view.

S. C. Sen, Kanpur.

The use of Hand Refractoor as an alternative and the usual polariscope one was first suggested in India by Khanna and Sen as early as 1934. They worked out a hyperbolic equation $Y=-0{\cdot}01104\ x^2+1{\cdot}484792-7{\cdot}79110$, where y and x=Pol. % and Brix % respectively of bullock crusher juice having about 60% extraction for predicting Pol % juice from Brix of juice. They also worked out a linear equation for predicting Brix of the stalk juice from middle internodal ref. brix by the equation $y=0{\cdot}76\ m+3{\cdot}85$ where y=stalk brix and m=middle internodal ref. brix.

Since the percentage of non-sugar varies with seasons and also within different periods of the season, it has been thought that probably still better fit would be obtained if two separate equations in place of one second degree equation are worked out. The difficulty lies in drawing this dividing line from consideration of ripening phases. The brix and pol % juice analysed for the past few years are plotted against each other in a graph to select the dividing line and two regression equations have been worked out statistically one with brix values 16·0 and above for high brix and the other with brix value below 16·0 for low brix. Equations are $y=1{\cdot}0486\ x-3{\cdot}527$ for high brix and $y=1{\cdot}131\ x-5{\cdot}039$ for low brix, where y=pol % juice and x=brix of the juice.

Since a large number of canes clumps are necessary for correct assessment of juice quality, roughly 1/10th of the lot, which is absolutely impossible at least on the spot, but the assessment of cane quality may be easily judged by extracting by hand refractometer and then assessing the pol % juice from this table.

7. A convenient New Method for the Large-scale Sterile Culture of Higher Plants.

M. M. R. K. Afridi, Aligarh.

A simple and reliable technique to grow large batches of plants under sterile conditions is presented here. A 3-5 litre beaker with a small central hole stoppered with a rubber bung through which passes a small glass tube, is kept on a suitable wooden base and is connected with a 3-5 litre aspirator bottle, containing 2·3 litre of nutrient solution, by means of a 3 meter long thick-walled rubber tubing. Each beaker contains 3-4 kilogram of sand mixed with 25-30 gram of Ca $(CO_3)_2$ to check 'ammonia injury' and to supply additional CO_2. The bung is loosely covered with

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some glasswool and on inverted watch-glass. The tops of the beaker and aspirator are covered with dishes, kept in position by means of cotton-wool pads. The apparatus is then sterilised at 121°C for an hour—8 such sets may be sterilised simultaneously in a Slater jacketed steam steriliser.

After surface-sterilisation for 3 minutes with 1% aqueous bromine solution followed by adequate washing, 30 seeds are sown asceptically in each beaker. Normally the aspirator is kept at a level below the beaker and is raised 3 times daily to supply the solution, after the seeds have germinated. Transplantation of separately germinated sterile seedlings gives slightly better results.

The method has proved very useful in nitrogen metabolism studies, requiring strict control of nitrification in the growth medium of experimental plants.

8. Nitrate Reductase Studies in Higher Plants : I. Sources of error in the method of assay and their prevention.

M. M. R. K. Afridi, Aligarh.

Two major sources of error occur in the nitrate reductase assay. First, the non-enzymic reaction between reduced diphosphopyridine nucleolide (DPNH) and NO_2, resulting in the loss of the latter. Medina and Nicholas (Biochim. Biophys. Acta *23* : 440, 1957) proposed a barium-alcohol precipitation method for removing residual DPNH, which was found by the present author to be time-consuming and inadequate when either much phosphate was present or the volume of the reaction mixture exceeded 1 ml. As detailed below, the use of alcohol dehydrogenase (ADH) to oxidise DPNH, thus rendering it unreactive with nitrite, has been found to be very convenient and reliable in preventing the error.

To the reaction mixture containing upto 0·4 mg. DPNH add, at the end of the reaction period, 1·45 mM of acetaldehyde, rapidly followed by about $0{\cdot}25\times10^3$ Racker units of ADH, which is available commercially, and may also be prepared from yeast, a fair preparation yeilding about 5×10^6 units of the enzyme in stable form.

The other major source of error in the colorimetric estimation of NO_2 by the Griess-Ilosvay method is caused by precipitation of protein by the acid sulphanilamide reagent. Centrifugation and resuspension of the pellet before colorimetric estimation failed to solve the problem. Several chemical denaturants of proteins were also found unsuitable.

Out of 7 detergents tried only sodium dodecyl (lauryl) sulphate was found to maintain the protein in a clear disperse state, after acidification, without interfering with nitrite estimations. 1 ml. of a 9 mg/ml. aqueous solution of pure sodium lauryl sulphate is sufficient to prevent upto 5 mg. of plant protein from precipitation.

The combined use of ADH and sodium lauryl sulphate is therefore recommended for rapid and accurate assay of nitrate reducatase as well as other allied enzyme systems.

9. Nitrate Reductase Studies in Higher Plants : II. The distribution of the enzyme.

M. M. R. K. Afridi, Aligarh.

A careful survey of plants of comparable age belonging to 15 different species of common plants grown in sand culture with nitrate as the source of nitrogen, showed that couliflower (*Brassica oleracea* var. *botrytis*), white mustard (*Sinapis alba*) and vegetable marrow (*Cucurbita pepo* var. *Ovifera*) had the highest activities of nitrate reductase, the activities noted being several times higher than those

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reported in soya bean by Evans and Nason (Plant Physiol. *28* : 233, 1953). The activities in the laminae of 3rd to 6th leaves were invariably much higher than those in (1) other leaves, (2) cotyledons, (3) petioles and stems. Spinach and seakale beets (*Beta vulgaris* var *Cicla*) and lettuce (*Lactuca sativa*) showed hardly any activity. Other species that showed consistently low activities included radish (*Rhaphanus sativus*), water cress (*Rorippa Nasturtium-aquaticum*), rape (*Brassica compestris* var. *Napus*), lucerne (*Medicago sativa*) and spinach (*Spinacea oleracea*), those showing fairly high activities were tobacco (*Nicotiana tabacum*), Mung bean (*Phaseolus radiatus* var. *mungo*), pea (*Pisum sativum*), tomato (*Lycopersicon esculentum*) and Sunflower (*Helianthus annuus*). Of the 6 British commercial varieties of cauliflower tested, Tremendous, and Majestic showed about double the activity exhibited by All The Year Round and 3 to 5 times that of Navo, Early Snowdrift and Lucifer.

In cauliflower and white mustard maximal activities were noted at age 5 to 10 weeks and 3 to 8 weeks respectively.

10. Effect of Plant regulator sprays on Sex, Fruit-set and Fruit Development in Cucumber (Cucumis sativus L.)

B. Choudhury *and* A. V. Patil, New Delhi.

Plant regulator sprays have been found to modify effectively the sex in cucurbits. Previous work at the Indian Agricultural Research Institute (Choudhury and Phatak, 1959 a, b and c, 1960) and other places (Laibach and Kribben, 1950 a, b and c, 1951, Laibach, 1951; Wittwer and Hillyer, 1954; Ito and Saito, 1956 a and b, 1957) have shown that different plant regulator sprays significantly increase the number of female flowers in cucumber. A study was conducted in 1960 in the Division of Horticulture, I.A.R.I., New Delhi to confirm the previous findings and also to investigate the effect on fruit set and fruit development. The plant regulators used were MH (50, 100, 200, 400 and 600 ppm), NAA (50, 100, 150 and 200 ppm), IAA (50 and 100 ppm), 2, 4-D (2·5 and 5 ppm) and GA (10, 25, 50 and 100 ppm). One set sprayed with distilled water was kept as control. MH at 50, 100 200 ppm, NAA at 50 and 100 ppm, IAA at 50 ppm and GA at 10 and 25 ppm significantly increased the number of female flowers than the control. All the treatments induced the early appearance of first female flower on the main axis. There was a high female to male flower ratio in the treated plants. The fruit set was also increased by plant regulator sprays. MH at 100 to 600 ppm, NAA at 100 to 200 ppm, IAA at 100 to 200 ppm, 2, 4-D at 5 ppm and GA at 10 to 100 ppm significantly increased the fruit set when compared to unsprayed plants. GA treatments brought about quicker development of fruits. The final number of fruits harvested however, increased only in the treatments NAA—50 to 200 ppm, IAA—50 ppm and GA 10 to 50 ppm. The size of individual fruit was not affected though the weight increased on Plants sprayed with MH—25 to 600 ppm, NAA—50 to 150 ppm, IAA—50 ppm and GA—10 to 100 ppm. The final yield of fruits per vine was increased by MH at 50 to 200 ppm, NAA at 50 to 200 ppm, IAA at 50 ppm and GA at 10 to 100 ppm.

11. Behaviour of mango varieties introduced from other States at Sabour (Bihar).

P. C. Mallik, T. S. N. Singh *and* S Pandey, Sabour.

Forty-eight varieties of choice mangoes from other States and few from within Bihar had been collected and grown at Sabour under identical condition to assess and compare their suitability in Bihar. After a quarter of a century's study, it

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can be safely said that a few of them have come out very successful. These varieties can come in commerce of the State.

The exotic plants have been categorised under different status according to their height and that again classified according to their canopy shape. So some of them can be recommended for beautifying the gardens in front of one, two or more storied buildings. Also, it is now possible to change the spacing in new orchards according to the height and spread of the trees.

12. Cytogenetical studies of some Inter-Generic Hybrids of Sugarcane. Saccharum officinarum (var. *vellai*) X *sorghum balepense* (Linn.) Pers. type (var. *Palestine*).

S. Govindaswami, Cuttack.

The inter-generic hybrids *Saccharum officinarum* (var. *vellai*) × *Sorghum halepense* and the back crosses obtained for getting fodder types were studied. In the F_1 hybrid there was autocyndetic pairing.

In the parent *Sorghum halepense*, a maximum of 2 quadrovalents were found while in the hybrid, where reduced complement of *Sorghum halepense* was present, occasional formation of tetravalent was also noticed leading to the inference that there may be some homology between one or two of *Sorghum halepense* chromosomes with those of *Sachharum officinarum*.

The back-cross (*vellai* × *Sorghum halepense*) × *Sorghum halepense* seedling G. 1938 has $2n=52$ chromosomes instead of the expected 50 chromosomes. These extra 2 chromosomes are inferred to be *Sorghum halepense* chromosomes from the observations of occasional irregular distribution of chromosome in the F_1 hybrid (i.e., G. 1227).

The seedlings namely Co. 559, Co. 560 and Co. 561 were obtained by selfing the sterile hybrid G. 1938 which had also $2n=52$ chromosomes but having distinct morphological character. These are inferred to have risen by parthenogenesis.

13. Observations on Inter-Racial (*Japonica* X *Indica*) crosses of rice (*Oryza Sativa*, L.). III. Sterility in the F_1 rice hybrids and its effect on the frequency distribution of some quantitative characters in the F_2 generation.

B. Misro, P. N. Sreedharan, V. K. Muralidharan *and* S. V. S. Prakash Rao, Cuttack.

Sterility is often met with in the F_1 hybrids of inter-specific, inter-racial and even inter-varietal crosses of the cultivated rice. Theoretically (i) the proportion of non-functional gametes in both the micro- and megaspores should be identical and (ii) the fertilization of one by the other should be random. Provided the above two conditions are satisfied, the frequency distribution of the phenotypes in the F_2 generation is expected to be normal. Data collected from six F_2 populations of inter-racial (*Japonica* × *indica*) crosses on three quantitative characters viz., height, flowering duration and effective tiller number have been presented.

Height is consistently showing significant skewness for all combinations having more than 52% sterility. The behaviour of flowering duration in this respect is less consistent and the effective tiller number is erratic. The nature of distribution of the phenotypes in the F_2 populations is not in any way affected by the fertility status of the soil. The implications of such an effect of sterility on the frequency distribution of the quantitative characters in F_2 for the genetical studies are discussed.

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14. Inheritance of certain Morphological characters in rice and their inter-relationships.

B. Misro, R. H. Richharia *and* M. V. S. Sastri, Cuttack.

The inheritance of "neck leaf", "polyhusked spikelet", beaked lemma, undulate rachis, verticillate panicle, awning, compact panicle and anthocyanin pigmentation in internode, leaf axil, lemma-palea, apiculus and awn in a cross between two rice varieties (Vis., Murasaki Koyabozu 836×T. 1) has been studied and their inter-relationships ascertained in the F_2 generation. The F_3 data confirm the F_2 observations.

The "neck leaf" and the "polyhusked spikelets" (often met with a teratological abnormalities) have been found to be genetically controlled. Beaked lemma is linked (i) with undulate rachis with a C.O of 46·82% and (ii) with one of the genes for pigmentation in leaf axil with a C.O of 16·6%. The verticillate panicle is linked with one of the genes for pigmentation in the apiculus, with a C.O of 36%. There is evidence of linkage between thirteen other pairs of characters.

Although genes for anthocyanin pigmentation have been reported in the first, second, third and fifth linkage groups of *japonica* rices, according to the present data, the pigmentation genes are also present in the seventh and ninth linkage groups. These data and those furnished in respect of suspected linkage lead one to believe that the linkage groups in the *indica* race may be somewhat different from the ones in the *japonica* race.

15. The Production, availability and requirement of Milk in India and its States in the perspective of Planning.

I. Chatterjee *and* S. Saha, Calcutta.

India's production of 5293·38 lakh maund of milk (46·71% from cow, 51·23% from buffalo and 2·06% from goat) works out a daily per capita availability of 5·26 oz. or almost half the amount recommended by ICMR. In Kerala, Assam, Orissa and West Bengal the availability varies from less than one-fourth and one-half of 5·26 oz., and in 16 out of 21 pre-reorganised states, and having a population of 315 millions or 89·6%, it lies between 1·27 oz., and 7·07 oz. Only Himachal Pradesh, Punjab, PEPSU, Saurastra, Rajasthan and Ajmer (with a population of 37 millions) have an availability from 20 oz. to 10 oz.

The authors have worked out the data both in terms of total and fluid fractions of per capita availability on the basis of states with more cow milk than buffalo, with cow and buffalo milk evenly proportioned, and with buffalo milk more than cow milk. The cow zone accounts for 31·16% of milk, even zone 4·8% and buffalo zone 64·04%.

A comparison has been made of this availability with the consumption data obtained by the National Sample Survey during 1950-51. There is a striking agreement between the all-India use of fluid milk and consumption, both being 1·97 oz. per capita per day. From their study a closeness is suggested.

Finally an examination has been made of the needed increase of milk production, if the per capita availability could be raised to 7½ oz., 10 oz., and 15 oz. On an all-India basis a 7½ oz. per capita availability requires a 43% increase of present production. Except in the better producing states increased production is needed from 6 to 7% in Madhya Bharat and U.P., and from 483% to 490% in Assam and Kerala.

A 10 oz. availability will require an increase of production by 90% in India, 41% to 43% in Madhya Bharat and U.P., and 677% to 687% in Assam and Kerala. A 15 oz. availability will need an increase of 185% for India, 112% to 114% for

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Madhya Bharat and U.P., and 1066% to 1088% for Assam and Kerala. These assessments are stressed as pre-requisites for proper planning. It also presupposes an assessment in terms of different States.

On overall basis only three states (Saurastra 1000 lb.), Delhi (1270 lb.) and Panjab (1445 lb.) show a yield over 1000 to 1445 lb. The rest vary from 65 lb. to 900 lb. On wet basis 12 states viz. Panjab (2514 lb.), Delhi (2261 lb.), Himachal Pradesh (1944 lb.), Bihar (1755 lb.), Rajasthan (1614 lb.), U.P. (1562 lb.), Saurastra (1480 lb.), PEPSU (1458 lb.), Madras (1274 lb.), "other areas" (1148 lb.), and West Bengal (1025 lb.) as also Indian Union (1037 lb.) show a yield from 1025 lb. to 2514 lb. whereas three states viz., Himachal Pradesh, Delhi and Panjab show a yield from a little less than 2000 lb. to over 2500 lb. Such differences and incidence of low and high extremes suggest that in India's peculiar condition the yield data in published statistics should be shown on both wet and dry basis.

Panjab, Delhi, Saurastra and PEPSU belong to top ranking area in more milk yield and lesser proportion of dry animals. A further decrease of dry animal will augment more milk production from cow. Himachal Pradesh and Rajasthan stand next with dry cows slightly in excess. Five states viz., Bihar, U.P., Madras, Travancore-Cochin and West Bengal have milk yield per wet cow varying from 1755 lb. to 1025 lb., but dry cows outnumber the wet cows at 1·83 : 1 to 1·44 : 1. Four states viz., Madhya Bharat, Orissa, Mysore and Jammu and Kashmir have still lower milk yield rates and still higher proportion of dry cows (1·74 : 1 to 2·28 : 1). Then stand Hyderabad, Vindhya Pradesh, Madhya Pradesh, Bombay and Assam with still decreasing milk yield rates. Hyderabad with Madhya Pradesh and Vindhya Pradesh needs an intensive reduction of dry cows, and a progressive reduction of cows in all states is overdue.

It is stressed that a reduction on a basis of 50 : 50 wet and dry cows is not likely to affect the production of the required number of working males, and that a planned reduction is imperative if we seriously want to increase our milk yield-cum-production.

16. The Factors affecting the production, availability and requirement of milk in India and its states in the perspective of planning.

I. Chatterjee *and* S. Saha, Calcutta.

Between 1951 and 1956 the average rates of milk yield in India have declined from 413 lb. to 361 lb. for cow and from 1101 lb. to 970 lb. for buffalo thereby reducing the per capita availability from 5·26 to 4·76 oz. and possibly still lower. In some states it is even less than one-fourth of India's availability. In terms of planning it implies a correspondingly greater production.

For such low production rates one important reason is the preponderance of dry cows over wet cows. In 15 out of 21 pre-reorganised states wet or milking cows constitute less than one-fourth (24·16) in Hyderabad whereas they are 30·48%, 30·58%, 33·72%, 35·34%, 35·37%, 35·77%, 36·67%, 39·93%, 40·70%, 41·06%, 42·76%, 45·26% and 46·37% respectively in Orissa, Mysore, Madhya Bharat, Madras, Bihar, Travancore-Cochin, Vindhya Pradesh, U.P., "other areas", West Bengal, Madhya Pradesh, Rajasthan and Himachal Pradesh. In India it is 39·87%. Only five states viz., Saurastra (67·69%), PEPSU (61·7%), Panjab (57·46%), Delhi (56·15%) and Assam (57·44%) have more wet cows, but the production of milk in Assam is very low. Bombay has wet and dry cows evenly divided. The consequence is that except in six states including Bombay, the dry cows exceed the wet cows in the proportion from 3·14 times in Hyderabad, to 2·28 times in Orissa and Mysore, 2 times in Madhya Bharat, 1·83 to 1·73 times in Madras, Bihar, Travancore-Cochin, Jammu and Kashmir, and Vindhya Pradesh, 1·5 to 1·34 times in U.P., "other areas", West Bengal and Madhya Pradesh, and 1·21 to 1·16 times in Rajasthan

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and Himachal Pradesh. Such a large proportion is reflected in a greater food cost for mere maintenance (from 4·14 times to 2·2 times per unit cow) leaving little margin on the productive side for milk. This results in low production and low availability. Such a large preponderance of dry cows reacts in the calculation of yields per cow on overall and wet basis and gives figures hardly indicative of the production potentials of the animal.

17. Methods for control of Udbatta or 'Agarbatti' *disease of rice.*

N. N. Mohanty, Bhubaneswar.

Udbatta or 'Agarbatti' disease of rice caused by *Ephelis oryzae* Sydow=*Balansia oryzae* Nar. and Thirumal. occurs in certain early and medium varieties of rice in Koraput, Kalahandi and Phulbani districts of Orissa. It has been observed to cause a loss up to 6% in yield in J_1, a susceptible variety of rice. The disease is manifested with the emergence of an erect greyish-white cylindrical axis much like 'Agarbatti' from the boot leaf sheath, which soon becomes greyish-black in colour. No grain is formed.

Field trials conducted to determine the nature of the disease indicated that the disease is mainly seed borne; since naturally infected rice seeds obtained from Jeypore and raised in sterilised soil at Bhubaneswar, where the disease is not prevalent, produced typical symptoms of the disease in some plants. In another experiment carried on for three years, it was found that, certain plants of some varieties of rice grown at Jeypore from the seeds obtained every year from Central Rice Resarch Institute, Cuttack, where the disease is not prevalent, could be infected with the disease showing thereby that, the infection could also take place through air or from soil. However, field experiments conducted at Jeypore during 1959 and 1960 indicated that the disease is not soil borne.

Different seed dressing chemicals viz. Agrosan G.N., Ceresan, Tillex and Captain; hot water treatments at 46°c, 54°c and 56°c for 10 minutes and solar heat treatment of the seeds before sowing were tried for four years (1957-1960)' for control of the disease. Hot water treatments at 50 to 56°c for 10 minutes and solar heat treatment of the seeds were found to be highly effective in controlling the disease. But, hot water tratment of seeds at 56°c had adverse effect on germination. The effect of different duration of solar heat treatment of seeds was tried and was observed that, solar heat treatment of seeds from 1 hour to 4 hours were effective in controlling the disease. The incidence of the disease was found to be less at Jeypore in case of early sowing (1st week of June) as well as late sowing (2nd week of July) than normal time of sowing (3rd week of June).

18. Weed Control in Wheat—A New Approach.

Anirudha Misra, Bhubaneswar.

Wheat is grown in Orissa as an irrigated second crop in the Rabi season. In this crop the majority of weeds (80-90%) are annual grasses. So the problem is the control of graminaceous weeds in a crop of the same family. That is why the weedicides specific to control monocot weeds could not be used. There was also no scope to give Pre-emergence spray as unlike Sugarcane, the time taken for germination of cereals is very short. So Pre-sowing spray of the soil was tried to control the annual grasses in the early stage of the crop.

The weedicides 2,4-D and MCPA were taken. Pre-sowing and Post-emergence sprays alone and together in different dose combinations were compared. Local practice of manual weeding was compared alone and in addition to the Pre-sowing

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sprays. In all, there were twelve main treatments and two sub-treatments in a layout of split plot design with three replications. Variety N.P. 718 was grown.

The difference among the treatments were statistically significant. The Pre-sowing spray was very effective as it controlled the growth of both Monocot and Dicot weeds in the early stage of the crop and the increase in yield of wheat ever control in the Pre-sowing treated plots was nearly 300%. Post-emergence application alone was of very little effect as it killed only the few Dicot weeds. Combinations of 2 lbs. pre-sowing spray with one pound post-emergence spray or manual weeding were the best giving nearly 500% extra yield over the control.

19. Field Tests of Insecticides for Control of Bhindi Jassids *Empoasca devastans* Distant.

G. C. SENGUPTA *and* J. N. DAS, Bhubaneswar.

The paper reports the results of the insecticides applied against jassid *Empoasca devastans* Distant. a serious pest of lady's finger (*Hibiscus esculentus*). The field trial was conducted on red variety of Bhindi during the year 1960 at the State Agricultural Research Station, Bhubaneswar. Five different treatments and one untreated plot were assigned to 5 replicates in randomized block design. The insecticides tried were (i) parathion 0·025%, (ii) endrin 0·025%, (iii) diazinon 0·025%, (iv) rogor 0·04% and (v) pyrocolloid (1 :800). In all, two sprayings of different insecticides were given. The first spraying was given 7 weeks after planting and the 2nd after an interval of 3 weeks. The percentage decline in the nymphal population 48 hours and one week after 1st and 2nd application was noted down and analysed statistically. It was observed that 48 hours after 1st and 2nd spraying, rogor, parathion, endrin and diazinon were almost equal in their toxicity and significantly superior to pyrocolloid. One week after the second application it was observed that the percentage decline in nymphal population in the plots treated with rogor was significantly superior to all other treatments. Endrin was significantly superior to parathion. Diazinon and pyrocolloid were almost equal in their toxicity and were far inferior to the above three treatments.

From the yield figures it was observed that rogor gave the best yield as compared with all other treatments.

20. An Annotated List of Some Parasitic Insects in Orissa.

G. C. SENGUPTA *and* J. N. DAS, Bhubaneswar.

An annotated list of 19 species of parasitic insects in Orissa is given. Mention may be made of *Encyrtid* sp., *Cheiloneurus* sp. and *Gitonides perspicax* Knab. on coffee mealy bug (unidentified); *Neodiscodes* sp. and *Gitonides perspicax* Knab. on casuarina mealy bug (unidentified); *Bracon* sp. (=*Habrobracon*) on *Earias fabia* Stoll. and *Euzophera perticella* Rag.; *Microplitis* sp. on *Prodenia litura* F. ; *Phanerotoma hendecasisella* Cam. on *Tirathaba* sp.; *Apanteles baoris Wilkinson, Exothecini*? Gen. et sp. (? *Xenosternum*), and *Eupteromalus Darnarae* Gah. on *Parnara mathias* F.; *Phanerotoma* sp. on *Margaronia indica* Saund.; *Cardiochiles* sp., *Temelucha* sp. ? *nigromaculata* Cam, and *Goniozus montanus* Kieff on *Cmaphalocrocis medinalis* Guen.; *Brachymeria* sp. on *Maruca testulalis* Gayer and *Nola* sp.; *Mepachymerus ensifer* Thoms. on *Schoenobius incertulas* Walk.; *Cremastus flavoorbitalis* Cam. on *Chilotraea infuscatellus* Sn.; *Pachyneuron* sp. on *Trialeurodes ricini* M.; *Closterocerus* insignis Wtrst. on coffee leaf miner (unidentified).

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Section XI, Physiology

1. Hippuric Acid Test as an index of Anxiety.

R. B. Mathur *and* S. Bhambal, Indore.

Study of liver function, has been undertaken in 32 Normal human subjects, in Malwa population, by the hippuric acid excretion test using the method of Quick. The values ranged from 3·67 to 5·01 gms. in the four hour period with an average of 4·62 grams.

An attempt has been made to investigate the effect of the stress of college examination.

The hippuric acid excretion did not show any significant correlation with other indices of anxiety like rise in blood pressure and Taylor's scale rating.

No significant correlation of hippuric acid excretion with surface area, urine volume was observed in normal human subjects.

The role of hippuric acid excretion as an index of anxiety has been evaluated along with other physiological concomitants of examination stress.

2. Effect of protection against summer Stress on respiration, pulse rate, water intake and fodder consumption of buffalo cows.

M. S. Misra, B. P. Sen Gupta *and* A. Roy, Mathura.

The problem of limiting effect of summer stress on animal productivity under tropical conditions can be tackled by focussing our attention on the desirability of modifying the climatic environments, the animals live in, in a way consistent with greater productivity. The present study was, therefore, designed to obtain, as preliminary step, quantitative informations on the influence of the important climatic elements on the various physiological responses under the two contrasting climatic environments under study.

Ambient Temperature ranged from 87·20-91·30°F. in the protected and from 86·0-108·10°F. in the unprotected group. Humidity showed a range of 52·10-61·50% in the former and of 29·70-46·0% in the latter. Both respiration and pulse in the unprotected group were significantly higher than those in the protected group during the period of actual stress. Respiration was found to have a high correlation with ambient temperature ($r=0·81$) whereas the pulse rate/temperature correlation was insignificant ($r=0·224$). The multiple correlation of temperature, humidity and respiration was high ($R=0·87$) indicating that the variations in respiration under the conditions of the experiment are mostly explained by temperature and humidity.

The multiple regression equation suggests that temperature is roughly four times more effective in causing variation in respirations than humidity.

Fodder consumption in the two groups were spectacularly distinct, the "protected" value being almost double of the "unprotected" one. Water intake, however, showed a reverse trend—the "unprotected group" intake being significantly more than that of the "protected group". Of all the physiological responses studied in relation to climatic stress, respiration appears to be of highest accuracy as a measure of heat tolerance.

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3. Beneficial effects of protection against summer stress on milk production in buffalo cows.

M. S. Misra, B. P. Sen Gupta *and* A. Roy, Mathura.

The present study was designed to establish, as a preliminary step, the extent of improvement in milk production that can be brought about by reorienting the concept of summer sheltering for milch animals, on a climatological as opposed to empirical basis, providing thereby the animals necessary protection against the main hazardous components of summer climate viz. temperature and radiation.

The climatic picture of the protected and unprotected groups were as follows :

Ambient temperature—Morning 86·7°F (87·5°F), Afternoon 90·8°F (101·1°F),

Relative Humidity—Morning 61·5% (46·0%), Afternoon 52·1% (29·7%),

Maximum Temperature—91·3°F (108·1°F),

Minimum Temperature—87·2°F (86·0°F),

Radiation Exchange from surroundings—Nil (58·0±3·4 KCal/Sq. m/hr) (In Animal Shed)

Figures in parenthesis are for the unprotected group. Both the morning and afternoon milk yields were higher in the protected group than their corresponding values in the unprotected lot, and the differences were highly significant. Within each treatment group again, the morning yield revealed a significantly higher value than the evening one, showing thus an inverse correlation with diurnal fluctuations of ambient temperature. Analysis of variance reveals that the greatest source of variation under the conditions of the experiment was between "treatments" (viz., protection vs. non-protection). The variation in the yield between week groups was also highly significant. There was also a significant variation in the milk yield from week to week within each "treatment" group.

The multiple correlation coefficient of milk yield, temperature and humidity (R=0·58) does not show a very high value which is suggestive that besides the temperature and humidity some other unexplained but important factors (climatic, physiological, nutritional etc.) are also responsible for a sizeable variation in the complex physiological processes of milk production.

The multiple regression of milk yield on temperature and humidity reveals that the ambient temperature was thrice more effective in influencing the productivity in the animals than the humidity.

The net outcome of the provision of protection against summer stress was 30% increase in milk yield which warrants its exploitation on a larger scale especially in the organised dairy farms.

4. Physical and Metabolic Behaviour of Jamnapari Goat and Bikaneri Ram Spermatozoa during Autumn.

M. S. Misra, B. P. Sen Gupta *and* A. Roy, Mathura.

The present study aimed to evaluate the quality of goat and ram semen during autumn so as to judge their respective suitability for use in artificial breeding programmes in these species consequent to "telescoping" the oestrous in the females during the same period.

The semen charactristics studied included ejaculate volume, initial motility, sperm concentration, percentage live, cold shock resistance as revealed by the

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percentage survival of spermatozoa following the treatment and oxygen uptake. The respective values are :—

$0{\cdot}92 \pm 0{\cdot}05$ ml ($0{\cdot}65 \pm 0{\cdot}072$), $4{\cdot}0 \pm 0{\cdot}42$ ($2{\cdot}28 \pm 0{\cdot}50$),

$5{\cdot}313 \pm 0{\cdot}786 \times 10^9$ ($4{\cdot}08 \pm 0{\cdot}46 \times 10^9$),

$87{\cdot}03 \pm 1{\cdot}8\%$ ($54{\cdot}55 \pm 4{\cdot}92\%$), $1{\cdot}82 \pm 0{\cdot}43\%$ ($6{\cdot}74 \pm 1{\cdot}56\%$),

$172{\cdot}7$ $\mu l / 10^9$ spermatozoa/hr. ($52{\cdot}34$ $\mu l / 10^9$ spermatozoa/hr.).

The values in the parenthesis are those of buck semen.

In general the goat spermatozoa appeared to be more adversely affected by the autumn climate as revealed by significantly lower values of these seminal attributes as compared to those of ram. The sperm concentration in the two species was, however, not significantly different.

The cold shock resistance did not reveal any predictable pattern in either species and was rather somewhat erratic. The ram spermatozoa showed practically no resistance to cold shock which otherwise appeared to be of a good quality judged by physical and metabolic attributes under study. Paradoxically the cold shock resistance of buffalo spermatozoa which had been shown to be intrinsically of a poorer quality than that of ram was many times superior under identical climatic environments.

In view of the poor quality semen obtained from goats during autumn, it is suggested to consider the advisability of shifting the breeding operation in this species to some other period of the year characterised by the availability of a reasonably better quality semen. In case of sheep, if the physical and metabolic indices under study are any indication, the choice of autumn for artificial mass breeding appears to be a rational approach.

5. Growth of Fistulated Animals and Standardisation of Methods.

H. C. Pant, J. S. Rawat *and* A. Roy, Mathura.

A preliminary study was undertaken on certain aspects of rumen physiology. Seventeen animals were used for the different investigations; out of these a few had permanent rumen fistulae fitted with air-tight plugs. Throughout the course of these investigations the composition and the amount of the concentrate mixture fed to the animals was kept constant. All the investigations were done with three species of ruminants viz. buffalo, sheep and goat.

The plug used to close the rumen fistula was found to maintain perfect anaerobiosis inside the rumen since the growth rate fistulated buffalo calves was found normal. No significant difference was obtained in the concentration of total volatile fatty acid (TFA) and ammonia (NH_3) as well as in the cellulolytic activity of rumen liquor obtained from fistulated and slaughtered animals maintained on the same plane of nutrition. It was concluded from this finding that the sampling technique for the collection of rumen liquor from fistulated animals gave samples which could be considered representative of the whole rumen ingesta. Starvation for 24 hours was found to decrease the cellulolytic activity of rumen inoculum as well as the concentration of TVFA and NH_3. By paper chromatography acetic, butyric, and propionic acids were separated from the rumen liquor. Digestion of cellulose *in vitro* gave rise to more propionic than acetic acid, whereas green berseem (Trifolium alexandrinum) produced the two acids almost in equal ratio.

Marked seasonal variation was observed in the cellulolytic activity of the rumen inoculum obtained from fistulated animals maintained on the same plane of nutri-

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tion. By *in vitro* technique the cellulolytic activity of rumen inoculum obtained from sheep and goat kept under indentical management were found to vary significantly, the activity in the former being lesser than that in the latter species.

6. Some observations on Respiration and blood pressure on stimulation of the cut central end of vagus and sciatic nerves.

V. S. C. Rao *and* M. S. Chaudhry, Jabalpur.

In a series of 10 dogs a study was undertaken to compare the response on stimulation of cut central end of vagus in the neck and abdomen with the response on stimulation of the cut central end of the sciatic nerve.

The response obtained on stimulation of the cut central end of vagus in the neck, or in the abdomen or the sciatic nerve showed sometimes the rise in blood pressure, sometimes a fall in blood pressure and sometimes a biphasic response. The response varied with the strength, duration and frequency of the current used for stimulation.

In the pressure response from the cut central end of cervical vagus the Traube Herings waves always disappeared. In the response obtained from the cut central end of abdominal vagus and sciatic nerve the Traube Herings waves never disappeared.

The response on the stimulation of cut central end of cervical vagus showed apnoea in large majority of observations, in some cases apnoea was followed by stimulation of respiration and in some there was slowing of respiration and in a few cases there was stimulation of respiration. The apnoea occurred at the end of normal expiration. On stimulating the cut central end of abdominal vagus and the sciatic nerve, stimulation of the rate of respiration was the only response obtained in all observations.

The conclusion drawn from these experiments suggests that the response obtained on stimulation of the cut central end of abdominal vagus and the sciatic nerve on blood pressure and respiration has probably a similar mechanism and supports the hypothesis that the pressure response obtained by stimulation on the cut central end of vagus is due to stimulation of the general afferent fibers present in the abdominal vagus.

Section XII. Psychology and Educational Sciences

1. Spontaneous Recovery in Probability Learning.

J. P. Das *and* A. K. Mitra, Cuttack.

In the present study an attempt has been made to demonstrate, if possible, the Spontaneous Recovery of a probability response. The probability learning task was a simple one. Two nonsense syllables—Jagapa and Kachada—were paired with adjectives 'good' and 'bad'. The probability of 'good' appearing after Jagapa and 'bad' after Kachada was 80 during acquisition serits. But during extinction series 'good' and 'bad' followed the two nonsense syllables with equal probability, i.e., ·50/·50. The trials for both acquisition and extinction remained constant. They were 280 trials, half of which were Jagapa and the other half Kachada, arranged in a predetermined random schedule. The *S*s would be asked to guess whether 'good' or 'bad' would follow immediately *E* called out the nonsense syllable. *S*s were required to record their guesses in paper, after which *E* announced 'good' or 'bad' according to the probability.

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Four groups of *Ss* each consisting of 20 male students, were taken. Of the four groups, two belonged to Experimental condition and the rest two to Control condition. Both the Experimental groups received the acquisition and extinction trials in one continuous session. Then a rest pause of 5 minutes was given to one group and 30 minutes to the other. Following rest, two tests for evidence of Spontaneous recovery were tried. This was done by requiring *Ss* to choose 10 adjectives for each non-sense syllable from a randomly presented list of 10 favourable and 10 unfavourable adjectives. In addition *Ss* were asked to rate the two nonsense syllables on three seven point scales (Good-Bad; Strong-Weak; Active-Passive). If Spontaneous recovery occurred, then choice of adjectives and ratings would be favourable for Jagapa which was followed by 'good' 80% of the time in acquisition and unfavourable for Kachada. Of course these response were compared with the responses of the control groups. Of the two control groups one group received only acquisition trials and the other only extinction trials. Then choice of adjectives, ratings for the two non-sense syllables were done. From the result it was found out that the two control and two experimental groups do not differ significantly from each other. No difference was also found between the two control and the two experimental groups. So it is not possible to conclude as to whether Spontaneous recovery has taken place or not. In that case at least the two control groups would have differed in their scores. The ·50 group (Second control group) should have been given positions mid between Good-Bad, but it was found that the first nonsense syllable Jagapa was judged to be good and the second syllable Kachada as bad. Then it was argued that probably when *Ss* were asked to judge two stimuli on a good-bad continum, they cannot give stimuli neutral places. They tend to see one as good and the other as bad. This haunch was subsequently proved by taking another two groups of *Ss* who were asked to choose adjectives for the nonsense syllables and rate them. These *Ss* had not received the probability learning trials before choosing adjectives and rating the scales. However while instructing the *Ss* the first nonsense syllable Jagapa was mentioned first to one group and the same was mentioned in the second place to the other group. It was found that favourable responses were given for the syllable that occurred first and unfavourable for the syllable that occurred in the second place.

A subsequent experiment was then designed with another two groups, each consisting of 20 *Ss*. The stimulus probability during acquisition was the same as in the previous experiment for acquisition. But for the extinction period the stimulus probability was reversed whereas in the first experiment it was ·50/·50. One of the two groups served as a control group for the reversed probability. The rest period before testing for Spontaneous recovery was 30 minutes. As expected it was found that the experimental group selected and rated the stimuli consistent with the stimulus probabilities of acquisition rather than those of extinction. Thus the phenomenon of Spontaneous Recovery was observed in the probability learning situation.

Section XIII. Engineering and Metallurgy

1. "Painting systems for Timbers".

M. M. Shirsalkar, S. M. Singh, G. W. Kapse *and* N. K. Patwardhan
Central Building Research Institute, Roorkee.

The scarcity of traditional timber viz., teak has led to the widespread use of secondary species (soft timbers) for making doors and windows etc. Unlike teak the nature of these timbers put a much more severe strains on the paint

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system. More often than not unseasoned timbers are used which further aggravates the situation. Under these circumstances suitable protective paint systems have to be found out for different species.

Outdoor exposure tests reveal that systems based on alumination primer perform well on soft timbers. In systems using alkyd finishing paint the undercoat did not influence the performance of the top finishing coat. Exterior finishing oil paints without undercoating performed better than with under coat. The life of the latter system is hardly 7/8 months, whilst the alkyd paints perform much better than oil paints and emulsion paints. The latter were found to put up a better performance on white lead primer than on aluminium primer. These paints suffered from mould growth. Emulsion paints did not offer protection for more than 9 months.

Further exposure studies on these paints on seasoned panels are in progress.

2. Characteristics of Induction Motor with D.C. Rotating Field.

P. KUNDU, Banaras.

Conventional induction motor is constructed with 'rotating magnetic field' produced by poly-phase alternating current in distributed poly-phase winding. Outer stator body or armature of a salient-pole alternator is put on two more bearings so that outer body can take continuous rotation. If now the D.C. salient-pole is excited and rotated by another prime-mover and armature short-circuited the outer body will move as an induction motor.

Characteristics of this induction motor is found to be similar to conventional motor if power-factor of armature circuit is high. If power factor is low demagnetising effect of armature will reduce D.C. field current and lesser amount of torque will be transmitted across air-gap by the D.C. rotating field.

Even with squirrel cage armature winding and with properly designed D.C. field winding continuous variation of speed of armature is possible over a considerable speed range by varying D.C. excitation. Construction of an 'one unit system' incorporating electric prime-mover and main variable-speed motor is suggested at the end.

From the similarity of Transformer-Induction Motor-Alternator secondary or armature side armature-reaction is viewed as equivalent to primary side load ampere turn.

Secondary leakage reactance is experimentally determined and found to be several times that measured by 'Potier Method'.

3. Influence of Acriflavine and of some Inorganic Inhibitors on the Dissolution of Steel in Sulphuric Acid.

C. K. MITAL, HIRA LAL and I. P. ANOSHCHENKO, Bombay.

1. The effect of acriflavine, stannous chloride, stannic chloride, and sodium bromide and their combinations on the dissolution of mild steel in 2 NH_2SO_4 has been investigated.
2. It has been shown that in air, at room temp., stannous chloride is a good inhibitor. The protective action of this inhibitor increases from 70·4% at a concn. of 1 mgM/L to 93·5% at a concn. of 10·0 mgM/L $SnCl_2.2H_2O$.
3. Under the same conditions, acriflavine is a good inhibitor. Even at a concn. of 0·25 mgM/L the protective action is 48·0%, and with an increase in concentration upto 3·0 mgM/L, protective action of the inhibitor is increased to 86%.

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4. Sodium bromide is a poor inhibitor for the corrosion of steel in H_2SO_4. Its protective action at 3 mgM/L is 39 and on increasing the concentration upto 20·0 mgM/L, the protective action does not exceed 69%.
However, a combination of NaBr and acriflavine (5·0 mgM/L NaBr+1·0 mgM/L acriflavine) and NaBr and $SnCl_2$. $2H_2O$ (5·0 mgM/L+5·0 mgM/L resptctively) gives a protective action exceeding 97%.
5. Some remarks have been made regarding the mechanism of inhibitor action.

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DISCUSSION

I. ABSOLUTE SUMMABILITY OF FOURIER SERIES

Section of Mathematics

Chairman : DR. P. L. BHATNAGAR, Bangalore.

1. T. PATI : *Absolute Riesz and Nörlund Summability of a Fourier Series.*

In the wake of the researches of Wang on the Riesz summability of a Fourier series at a point, Mohanty (PLMS, 1951) obtained certain preliminary results on the absolute Riesz summability of a Fourier series, its conjugate series and their derived series. These results of Mohanty were superseded and generalised in the works of Pati (Trans. Amer. Math. Soc., 1954; Proc. NISI, 1957), Matsumoto (Tôhoku Math. Jour., 1957) and Sinha (Proc. NISI, 1958). The ultimate result in this direction bridges the gap between Bosanquet's classical results on $|C|$ summability and Pati's theorems on $|R, \exp\{(\log w)^{1+1/\alpha}\}, \alpha+\delta|$ for $\delta > 0$. Matsumoto's theorem for Fourier series, which is the most general, is esablished essentially through a conjunction of the techniques developed by Pati and certain standard formulae readily available in Bosanquet's work, while Sinha's results, which are coextensive with Matsumoto's in the case of integral α and cover the conjugate and derived series also, are obtained entirely by means of techniques developed by Pati.

A curious Tauberian technique was hit upon by Mohanty for proving an analogue of Hardy-Littlewood's convergence criterion for Fourier series, and instead of working with Valiron means, which Hardy and Littlewood had used, Mohanty had used the basic result (PLMS, 1949) : If $\Phi(t) \log(k/t) \in BV(0, \pi)$, then the Fourier series of $\Phi(t)$ at $t=0$ is summable $|R, \exp(\omega^{\delta}), 1|$ where $0 < \delta < \infty$. This is an analogue of a theorem of Wang.

On absolute Riesz logarithmic summability we have results from Izumi and Kawata (Tôhoku Math. Jour., Vol. 45) and Mohanty and Mohapatra (Math. Zeitsch., 1956).

Although on the absolute Nörlund summability of Fourier series of Lipschitz class, several results had been obtained by Mc Fadden as early as 1942 (Duke Math. Jour.) as generalisations of previous results of Hyslop and others, it is remarkable that nothing had been done with regard to the absolute Nörlund summability of the Lebesgue-Fourier series until in 1959 Pati's paper on this subject was published in the Journal of the London Math. Soc. Subsequent work by Pati in this direction has been partly announced in the volume of Abstracts of the Proc. of the current session of the Indian Science Congress. These results generalize results of Bosanquet and Hyslop.

Pati has meanwhile also tackled the problem for differentiated Fourier series and also generalised certain other previous results of Bosanquet on $|C|$ summability by using Nörlund means.

The most remarkable result, however, seems to be the following theorem by Pati (forthcoming in the Jour. Indian Math. Soc.) : If $\Phi(t) \log(k/t) \in BV(0, \pi)$,

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or even ε AC $(0, \pi)$, it is *not* necessary that the Fourier series of Φ (t) at t=0 is summable $|N, 1/(n+1)|$. This establishes that Iyengar's well-known theorem on Harmonic summability has no direct analogue for absolute summability.

2. PRAMILA SRIVASTAVA (Allahabad) : *Absolute Abel Summability and Absolute Cesàro Summability of a Fourier Series.*

It was in 1911 that Fekete introduced the notion of absolute Cesario summability and absolute Abel summability was introduced by Whittaker in 1930. The relationship between the two methods of summability may be expressed by $|C, \alpha| \subset |A|$, for every $\alpha \geqslant 0$. The first result on absolute summability of a Fourier series due to Whittaker (P.E.M.S., 1930) states that under Dini's criterion for convergence a Fourier series is summable $|A|$. The question as to whether at least for a Fourier series $|A| \subset C$, or vice versa, was answered in the negative by Whittaker (loc. cit.) and Prasad (P.E.M.S., 1930). Theorems on summability $|A|$ and summability $|C|$ have been obtained among others by Prasad (P.L.M.S., 1933), Misra (P.M.S.I., 1933) and Bosanquet (P.E.M.S., 1934; J.L.M.S., 1936; P.L.M.S., 1936). The most comprehensive results in this direction due to Bosanquet are to the effect that if $\Phi\alpha(t) \varepsilon$ BV $(0, \pi)$, then the Fourier series is summable $|C, \beta|$, $\beta > \alpha \geqslant 0$, and if the Fourier series is summable $|C, \alpha|$, $\alpha \geqslant 0$, then $\phi\beta(t) \varepsilon$ BV $(0, \pi)$, $\beta > \alpha+1)$. Hence it follows that summability $|C, \delta|>1$, is a local property. That this is not true for $o<\delta \leqslant 1$ was demonstrated by Bosanquet and Kestelman (P.L.M.S., 1939) and also by Randel's (B.A.M.S., 1940). Randels (B.A.M.S., 1938) gave an example to show that for a Fourier series also $|A| \Phi |C|$. Summability $|C|$ of a Fourier series of a function belonging to the class L^p has been investigated by Alberto Foa (B.M.I., 1940 and 1941), Yano (T.M.J., 1953), Sunouchi (J.M.S., Japan, 1949) and Tsuchikura (M.J., 1949; T.M.S., 1953). For summability $|C|$ of Fourier series of functions of the *Lipchitz class* investigations have been made by Hyslop (P.L.M.S., 1937) and Chow (P.L.M.S., 1937 and J.L.M.S., 1942). Yet another class of criteria for summability $|C|$ of a Fourier series, which may be said to be of the *Dini Lipchitz* type, have been developed. Matsuyama (T.M.J., 1950) and Chow (J.L.M.S., 1955). Still further results in this direction have been recently obtained by K. Yano (T.M.J., 1960) and by Hsiang (P.A.M.S., 1960).

3. S. N. BHATT (Allahabad) : *An aspect of local property of absolute summability of a Fourier Series* (Presented at the symposium by Z. U. Ahmad).

1.1. Let f (t) be a periodic function with period 2π and integrable L over $(-\pi, \pi)$, and let its Fourier series be

$$\sum A_n(t) = \tfrac{1}{2} a_0 + \sum_{n=}^{\infty} (a_n \cos nt + b_n \sin nt).$$

1.2. Bosanquet, in 1936, proved that the summability $|C, \alpha|$, $\alpha > 1$, of a Fourier series is not a local property. Bosanquet and Kestelman have proved, however, that the summability $|C, 1|$ of a Fourier series at a point is not a local property

I have proved that a *necessary and sufficient condition that* $|C, 1|$ *summability of a Fourier Series be a local property is that* $\Sigma |A_n k|/n$ *is convergent.* The problem for the case $|C, \beta|$ summability where $o<\beta \leqslant 1$ was tackled by Jurkat and Peyerimhoff. I have recently established that *if* p_n *is non-negative, monotonic non-increasing,* $P_n \to \infty, P_n = O(n^\delta)$ $(o \leqslant \delta < 1)$ and $\Sigma |A_n(x)/P_n < \infty$, *then* $|N, p_n|$

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summability of $\Sigma A_n(t)$ *is a local property.* This theorem which is of extremely general character includes as a particular case the above mentioned theorem of Jurkazt and Peyerimhoff.

1.3. Mohanty and Izumi have independently generalised the theorem of Bosanquet and Kestelman by proving that the summability $|R, \log n, 1|$ of a Fourier series is a non-local property. Matsumoto further generalised this theorem by proving that the summability $|R, \log n, 1|$ of even the series $\Sigma A_n(t)/\log \log (n+1)$ cannot be ensured by a local hypothesis. This result has recently been extended by Dikshit for general Riesz summability $|R, \lambda_n, 1|$.

Mohanty and Izumi have proved that if $\Sigma \{|A_n(x)| \log \log n\}/n$ be convergent then the $|R, \log n, 1|$ summability of a Fourier series at a point is a local property. I (Tôhoku, Vol. II (1959)) have generalised this theorem by proving that *a necessary and sufficient condition that the summability* $|R, \log n, 1|$ *of a Fourier Series be a local property* is that $\Sigma \frac{A_n(t)}{n \log n}$ is *convergent.* The general case of $|R, \lambda, 1|$ summability has recently been discussed by Dikshit and corresponding result which is parallel to that of mine has been given.

2.1. Matsumoto proved that $|C, 1|$ summability of a factored fourier series $\Sigma A_n(t)/\log n)^{1+\varepsilon}$, $\varepsilon > 0$, can be ensured by a local condition. This result of Matsumoto is included in the following theorem established by Prasad and myself (Duke J.M., Vol. 24 (1957)).

If $\{\lambda_n\}$ is a convex sequence such that $\Sigma n^{-1} \lambda_n$ is convergent and $t_n^1 = o(\log n)^k$ $(C, 1)$, $k \geqslant o($ then the series $\Sigma \{\log (n+1)\}^{-k} \lambda_n a_n$ is summable $|C, 1|$ where t_n^1 denotes n^k Cesàro mean of order one of sequence $\{na_n\}$. The particular case of this result for $k = o$ is due to Pati. Since when a series is convergent $t_n^1 = o(1)$ as $n \to \infty$ and since convergence is a local property, it follows that *if* λ_n *is a convex sequence such that* $\Sigma n^{-1} \lambda_n$ *is convergent then the summability* $|C, 1|$ *of the factored Fourier series* $\Sigma A_n(t) \lambda_n$ *at a point is a local property.*

2.2. Mohanty has demonstrated that the summability $|R, \log n, 1|$ of $\Sigma A_n(t)/\log (n+1)$ at $t = x$, is a local property of the generating function of $\Sigma A_n(t)$. I (P.N.I.S. Vol. 26. A 1960) *have generalised this result by proving that if* $\{\lambda_n\}$ *is a convex sequence such that the series* $\Sigma n^{-1} \lambda_n$ is convergent then the $|R, \log n, 1|$ summability of the series $\Sigma A_n(t) \log n \lambda_n$ *at a point can be ensured by a local property.* The result obtained includes as a particular case a previous result of Matsumoto.

Very recently, S. N. Lal has proved that the absolute harmonic summability of the factored Fourier series $\Sigma n^{-1} \varepsilon \{\log \log (n+1)\}^{-1} A_n(t)$, $\varepsilon > o$, can be ensured by a local condition. He has also established some important results on the localisation of absolute summability of the derived series of a Fourier series.

4. S. R. SINHA (Allahabad) : *Absolute Abel and Cesaro Summability Factors.*

1. A given series Σa_n is said to be absolutely summable (A), or summable $|A|$, if $F(x) = \Sigma a_n x^n$ is convergent for $|x| < 1$, and $F(x)$ is a function of bounded variation in (o, 1).

The series Σa_n is said to be absolutely summable (C, ρ), or summable $|C, \rho|$, if the sequence $\{s_n\}$ of n-th Cesàro means of order ρ $(\rho > -1)$ of partial sums s_n of Σa_n, is of bounded variation, that is,

$$\Sigma |s^{\rho}_n - s^{\rho}_{n-1}| < \infty.$$

Summability $|C, \rho|$, $\rho > -1$, implies $|A|$, but not conversely.

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2. Let f(t) be integrable (L) over $(-\pi, \pi)$, and periodic 2 , and let its Fourier series be given by

$$\sum_{n=1}^{\infty} (a_n \cos nt + b_n \sin nt) \equiv \sum_{n=1}^{\infty} A_n(t),$$

and

$$\phi(t) = (1/2)\{f(x+t)+f(x-t)-2f(x)\}.$$

3. Prasad (P.L.M.S., 1933) was the first to investigate into the problem of factors in the theory of Absolute Summability. He established the following theorem on |A|-summability factors.

If
$$\int_0^t |\phi(u)|\, du = o(t), \text{ as } t \to 0, \quad \ldots\ldots\ldots\ldots \quad (1)$$

then $\Sigma \lambda_n A_n(x)$ is summable |A|, where $\{\lambda_n\}$ is any one of the sequences

$$\{(\log n)^{-1-\varepsilon}\}, \{(\log n)^{-1} (\log \log n)^{-1-\varepsilon}\} \ldots, \ldots\ldots\ldots \quad (2)$$

$$\{(\log n)^{-1} (\log \log n)^{-1} \ldots (\log \log \ldots \log_p n)^{-1-\varepsilon}\}, (\varepsilon > 0).$$

In 1938, Izume and Kawata extended this result to the case of factors λ_n, where $\{\lambda_n\}$ is a convex sequence such that $\Sigma(\lambda_n/n) < \infty$. Cheng in 1948 extended Prasad's theorem by replacing summability |A| by summability $|C, 1+\delta|$, $\delta > 0$. In 1954 Pati generalised all these results by replacing sequence (2) in Cheng's theorem by a convex sequence $\{\lambda_n\}$, when $\Sigma(\lambda_n/n) < \infty$.

This result has been further extended by Dikshit (Bull. Cal. Math. Soc., 1958) by replacing (1) by

$$\int_0^t |\Phi_h(u)|\, du = 0\,[t\{\log (1/t)\}^{\beta}], \quad \beta > 0, \quad \ldots\ldots \quad (3)$$

as $t \to 0$, and $\Phi_h(t)$ is the Riemann-Liouvelle integral mean of Φ of order h, where $h = 0$, and the sequences (2) by $\{\lambda_n (\log n)^{-\beta}\}$, $\{\lambda_n\}$ being a convex sequence, and such that $\Sigma(\lambda_n/n) < \infty$.

Recently Pati and Sinha (Indian Journ. Math., 1958-59) have generalized Pati's result in another direction by the introduction of a new concept of hyper-convexity'. A sequence is said to be 'hyperconvex of order h' ($h = 0, 1, 2, \ldots$) if $\Delta^{h+2} \lambda_u \geq 0$. By definition 'hyper-convexity of order zero' is the same as 'convexity'. They proved that—if (3) holds with $\beta = 0$, and if h be an integer ≥ 0 and $\{\lambda_n\}$ be a monotonic non-increasing sequence when $h = 0$, and a hyper-convex sequence of order $(h-1)$ when $h \geq 1$, such that

$$\Sigma n^{-1} \lambda_n < \infty \text{ and } \Sigma n^h \Delta^{h+1} \lambda_n < \infty,$$

then the series $\Sigma \lambda_n A_n(x)$ is summable $|C, h+1+\delta|$ for every $\delta > 0$.

The result has been further generalized and extended by Ahmad in the following form and includes all the previous results known in this line.

Let h he an integer ≥ 0, and let $\{\lambda_n\}$ be a sequence such that $\Delta^{h+1} \lambda_n > 0$, and $\Sigma(\lambda_n/n) < \infty$. Then, if (3) holds, the series $\Sigma A_n(x) \{\lambda_n (\log n+1)^{-\beta}$ is summable $|C, h+1+\delta|$, for every $\delta > 0$.

Chow established (J.L.M.S., 1941) that for a convex sequence $\{\lambda_n\}$ such that $\Sigma(\lambda_n/n) < \infty$, the series $\Sigma \lambda_n A_n(t)$ is summable $|C, 1|$ for almost all values of t. He based the proof of his theorem on a result of Marcinkiewicz concerning the strong summability of Fourier series. The set of points at which his result holds, is not necessarily the Lebesgue set in which Prasad's theorem holds. The

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question naturally arises as to whether the summability $|C, 1|$ of $\Sigma \lambda_n A_n(x)$ can be ensured by the condition (1), taking the $\{\lambda_u\}$ to be a convex sequence such that $\Sigma n^{-1} \lambda_n < \infty$, and $f(t)$ be just integrable (L). This remains an open question even in the special case $\lambda_n = (\log n)^{-1-\varepsilon}$, $\varepsilon > 0$. The analogous question for power series on its circle of convergence has, however, been considered by Pati (Abstracts, IMS Conf., 1959) who has proved the following result with the help of a general theorem of his on the absolute Cesáro summability factors of infinite series and a previous theoorem bq Hardy and Littlewood on the strong summability of power series on its circle of convergence.

If $f(z) = \Sigma c_n z^n$ is a power series of complex class L, such that

$$\int_0^t |f(e^{i\theta})| \, d\theta = 0 \quad (|t|), \text{ as } t \to 0, \quad \ldots\ldots\ldots \quad (4)$$

the $\Sigma \lambda_n c_n$ is summable $|C, 1|$.

Cheng (Duke Math. Jour., 1948) proved that if $0 \leqslant \alpha \leqslant 1$, and $\Phi_\alpha(t)$ is of bounded variation in $(0, \pi)$, then $\Sigma \lambda_n A_n(x)$ is summable $|C, \alpha|$, where $\lambda_n = (\log n)^{-1-\varepsilon}$, $\varepsilon > 0$. Subsequently Sunouchi in 1954 extended this result to all positive values of α, and Ahmad has extended Sonouchi's theorem still further. In 1957 Prasad and Bhatt (Duke Math. Jour.) also generalized Chen's theorem in another direction and proved some new results on the $|C|$-summability factors of Fourier series. Recently some of the theorems of Prasad and Bhatt have been extended by Dikshit (PNISI, 1959).

Several other extensions and generalizations of the theorems of Cheng (Duke Math. Jour., 1947-8) have been effected by Cheng himself, Prasad and Bhatt, Dikshit and Srivastava (PNISI, 1958), of which Srivastava's result is the most general one.

5. G. D. DIKSHIT (Allahabad) : *Absolute Riesz Summability Factors for a Fourier Series.* (Presented at the Symposium by Mr. B. D. Malaviya).

In the study of absolute Riesz Summability of Fourier Series the theory of summability factors was for the first time employed in 1951 by Mohanty. In an earlier paper [P.L.M.S. (2), 51 (1950)] he had proved that if $\Phi(t) \left(\log \frac{k}{t}\right) \varepsilon$ Bv (o, π), $k > \pi$, then the Fourier series $\Sigma A_n(t)$ of $f(t)$, at $t = x$, is summable $|R, \exp(n^\alpha), 1|$, where $\Phi(t) = \frac{1}{2}[f(x)+t)+g(x)-t)-2f(x)]$, and $O < \alpha < i$. He took up the problem of determining the sequence of summability factors in order that the factored Fourier series may be summable $|R, \exp(n^\alpha), 1|$, when only it is known that $\Phi(t) \varepsilon$ Bv (o, π), and showed that the sequence $\left\{\frac{1}{\log(n+1)}\right\}$ serves to be one [P.L.M.S. (2), 52 (1951)]. In 1954, Mohanty and Misra took up the problem of absolute Riesz summability of the type $\{\exp(\log n)^\beta\}$, $\beta > 0$, and proved that if $\Phi_\alpha(t)$—the α-th integral mean of $\Phi(t)$—is a function of bounded variation in $(0, \pi)$, for $0 < \pi < 1$, then the factored series $\Sigma A_n(t) \{\log(n+1)\}^{-1}$, at $t = x$, is summable $|R, \exp(\log n)^{1+\frac{1}{\alpha}}, 1|$ [T.M.J. (2), 6 (1954)]. Recently considering the general cases for $\alpha \geqslant o$, Dikshit has proved that if $\alpha \geqslant o$, $\beta \geqslant o$, $\Phi_\alpha(t)$ $\left(\log \frac{k}{t}\right)^{\alpha\beta} \varepsilon$ Bv $(0, \pi, k > (\pi+1)$, then the factored series $\Sigma A_n(t) \{\log(n+1)\}^{-\delta}$ at $t = \pi$ is summable $|R, \exp(\log n)^{\beta\alpha}|$, where $\delta > 1 + \alpha\beta$, and also in the case $\beta > 1$, $o < \alpha < \frac{\beta-1}{\beta}$, $\delta \geqslant \beta$ [Indian J.M., 3 (1961)]. Very recently the special case, $\alpha = 1$, of this theorem has received a further generalization at the hands of S. N. Lal who

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has proved that if $\Phi_1(t) \in Bv(0,\pi)$, then the series $\Sigma A_n(t)\{\log(n+1)\}^{-1-\varepsilon}$, at $t=x$, is summable $|R, \exp(\log n)^{\beta}, 1|$ for $\beta, \varepsilon > 0$ (Abstract of the paper to appear in 'ABSTRACT OF PAPERS' presented for the twenty-seventh Conference of the Indian Mathematical Society, Ahmedabad, 1961).

Matsumoto applied the theory of summability factors to study the absolute Riesz summability of a Fourier series in another direction. He first proved that absolute Riesz summability of certain logarithmico-exponential types and order unity of a Fourier series is not a local property. Then he investigated into the nature of the sequence of summability factors which can make the factored Fourier series summable at a point under consideration and gave a set of results. Actually he has given summability-factor-sequences $\{l_n\}$ so that the series $\Sigma A_n(t) l_n$ may be summable $|R, \lambda_n, 1|$, where the type sequence $\{\lambda_n\}$ is of either forms : $\exp(n^{\alpha})$, $0<\alpha<1$; $\exp(\log n)^{\beta}$, $\beta>0$, and $\exp(\log n)^{\beta}$, $\beta>0$, and the function $\Phi(t)$ satisfies certain Lebesgue-set type of conditions [T.M.J. (2), 8 (1956)]. Results of Matsumoto have been generalized as far as summability factors are concerned by Pramila Srivastava (ABSTRACTS, P. I.S.C.A., 45th Session, Madras 1958).

6. S. M. MAZHAR (Allahabad) : *Absolute summability with indices.*

1.1. Let $f(t)$ be a periodic function with period 2π and integrable (L) in $((-\pi, \pi)$ and let its Fourier series be given by

$$f(t) \sim \sum_{0}^{\infty} A_n(t).$$

and suppose that the series conjugate to Fourier series is

$$\sum_{0}^{\infty} B_n(t).$$

We write

$$\varphi(t)) = f(x)+t)+f(x-t),\ \Psi(t) = f(x)+t)-f(x-t),$$

$$\Phi_n(t) = \frac{1}{\Gamma(\alpha)} \int_0^t (t-u)^{\alpha-1} \varphi(u)\, du \quad \alpha>0,$$

and

$$\Phi_0(t) = \varphi(t)$$

Let t_n^{β} denote the n-th Cesáro mean of order β of the sequence $\{nA_n(x)\}$, $\bar{t}_n^{\beta}$ that of $\{nB_n(x)\}$ and σ_n^{β} that of $\Sigma A_n(x)$.

1.2. It was Flett (P.L.M.S. (3), 7 (1957), 113-141) who, for the first time, introduced the notion of absolute summability with index k. Thus according to him a series Σa_n is said to be summable $|C, \alpha|_k$, $k \geqslant 1$, $\alpha > -1$, if $\Sigma n^{-1} |T_n^{\alpha}|^k < \infty$ where T_n^{α} is the nth Cesáro mean of order α of the sequence $\{na_n\}$. Later on he further extended his definition by introducing an additional parameter γ, which states that a series Σa_n will be said to be summable $|C, \alpha, \gamma|_k$, $\gamma \geqslant 0$, if $\Sigma n^{k\gamma-1} |T_n^{\alpha}|^k < \infty$ (P.L.M.S. (3), 8 (1958), 357-387).

2.1. Utilising the general principle that the relation of $\bar{t}_n^{\beta}$ to $\Psi(t)$ is essentially the same as the relation of $t_n^{\beta-1}$ to $t\varphi'(t)$ and as that of $\sigma_n^{\beta-1} - s$ to $\varphi(t)^* \equiv \varphi(t) - 2s$, he (P.L.M.S. (3), 8 (1958), 258-311) proved two sets of inequalities for Fourier series and with the help of some of these results, he obtained a theorem parallel to that of Bosanquet (Theorem 1, P.L.M.S., 41 (1936), 517-528). However it may be observed that although one of his results for conjugate series

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generalizes a theorem of Bosanquet and Hyslop (Math. Zeit., 42 (1937), 489-512), his generalization of Bosanquet's theorem to index k is 'less obvious'.

No converse theorem involving necessary condition for summability $|C, \alpha|_k$ has so far been obtained. However there is every possibility that a result analogous to that of $|C, \alpha|$ summability may hold true for it.

Flett has also proved some theorems concerning the summability $|C, \alpha|_k$ of $\Sigma n^{\alpha} A_n(x)$, which are analogous to those of Fourier series.

In another paper Flett (P.L.M.S. (3), 8 (1958), 357-387) has studied the summability $|C, \alpha, \gamma|_k$ of Fourier series, the results obtained by him are analogous to those proved for summability $|C, \alpha|_k$. With the help of one of these theorems he has investigated the local property problem for the summability $|C, \alpha|_k$ of the Fourier series of L^p class. In this connection he has obtained a set of results concerning the local property and has shown that his results are best possible. It may be remarked that his theorems generalize, in the case of local property, theorems of Bosanquet, Foà and Tsuchikura and in the case of non-local property, theorems of Bosanquet and Kestelman, Foà, Yano, Tsuchikura and Jurkat and Peyerimhoff.

2.2. In 1959, Yano and Tsuchikura (Tôhoku Math. J. II (1959), 456-479) introduced a modified definition of summability $|C, \alpha|$ with indices k and p. Thus according to them a series Σa_n is said to be summable $\{C, \alpha\}_{k, \rho}$, where $k>0$, $p \geqslant 1$, if

$$\sum_{n=1}^{\infty} \left(\frac{1}{2^n} \sum_{j=2^n}^{j=2^{n+1}-1} \left| T_j^{\alpha} \right|^{\rho} \right)^{k/p} < \infty.$$

It has been shown by them that $|C, \alpha|_k \sim \{c, \alpha\}_{k, p}$ for $k=p \geqslant 1$.

Generalizing a result due to one of the authors (Tsuchikura, Tôhoku Math. J. S., 5 (1954), 302-312), they proved two theorems for Fourier series, their main theorem being analoguos to that of a theorem of Flett.

3.1. In order to generalize various results known for summability $|C, \alpha|_k$ and summability $|C, \alpha, \gamma|_k$, Mazhar (Proc. Nat. Inst. Sci. India, 26A (1960), 160-167, Indian J. Math., 2 (1960), 119-124) introduced the definition of summability $|R, \lambda, \alpha|$ with indices k and γ. His definitions are as follows :

A series Σa_n is said ti be summable $|R, \lambda, \alpha|_k$ if

$$\int_A^{\infty} w^{k-1} \left| \frac{d}{dw} C_{\lambda}^{\alpha}(w) \right|^k dw < \infty.$$

where $C_{\lambda}^{\alpha}(w)$ is the Riesz mean of type λ and order α, $k \geqslant 1$, $\alpha > 0$ and $\alpha k/(k-1) > 1$.

And the series Σa_n is said ro be summable $|R, \lambda, \alpha, \gamma|_k$ $\gamma \geqslant 0$, if

$$\int_A^{\infty} w^{k\gamma+k-1} \left| \frac{d}{dw} C_{\lambda}^{\alpha}(w) \right|^k dw < \infty.$$

It is known that $|R, n, \alpha, \gamma|_k \sim |C, \alpha, \gamma|_k$ for $\alpha \geqslant \gamma - 1/k$.

He has studied various properties of these summability methods (Proc. Math. Inst. Sci. India, 26A (1960), 160-167, Ibid., 27A (1961), ii-17, Indian J. Math., 2 (1960), 119-124) and has investigated their application to infinite series (Abstract to be published in Proc. ISCA, 1962).

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Generalizing a number of theorems due to Matsumoto (Tôhoku Math. J., 8 (1956), 114-124), Mazhar (In an unpublished paper) has obtained the following theorems for factored Fourier series.

Theorem A. *If*

$$\int_0^t |\varphi(u)|\,du = O\left\{t/\log\frac{k}{t}\right\},$$

k being a suitable constant, then the series $\Sigma \dfrac{A_n(t)}{\left\{\overset{\Delta}{n}\log(n+1)\right\}^{1/k}}$, *at* $t=x$, *is summable* $|R, e^{\overset{\Delta}{n}}, 1|_k$, *where* $k \geqslant 1$, $0<\Delta\leqslant 1$ *and* $\varepsilon>0$.

Theorem B. *Under the hypothesis of Theorem A, the series* $\Sigma A_n(t)/\{\log(1+n)\}^{\frac{\Delta+\varepsilon}{k}}$, *at* $t=x$, *is summable* $|R, e^{(\log n)^{\overset{\Delta}{}}}, 1/k|$, *where* $k\geqslant 1$ *and* $\Delta>0$.

Theorem C. *If*

$$\int_0^t |\varphi, u)|\,du = O\left\{t/\log\frac{k}{t}\log\log\frac{k}{t}\right\},$$

then the series $\Sigma \dfrac{A_n(t)}{\{\log\log(in+1)\}^{\Delta+\varepsilon)/k}}$, *at* $t=x$, *is summable*

$$|R, e^{(\log\log n)^{\overset{\Delta}{}}}, 1|_k, \Delta>0.$$

He has further shown that in the case $k=2$, these theorems can be proved even under a lighter condition, namely

$$\int_0^t |\varphi(u)|\,du = O\left\{t/\log\frac{k}{t}\right)^{\alpha}\Big\}, \quad \alpha>\tfrac{1}{2}$$

II. MAGNETO-HYDRODYNAMICS

Chairman : Dr. P. L. Bhatnagar, Bangalore.

1. C. DEVANATHAN (Bangalore) : *Oscillations of a Three Component Assembly with or without magnetic field.*

The plasma is taken to be composed of singly ionized molecules, free electrons and neutral molecules, each of the component being described by the hydromagnetic equations, modified to take into account the displacement current, existence of free charge in the medium, and the modified current equation without involving the scalar conductivity. The basic equations are linearized and only small amplitude waves are considered. In the absence of any external magnetic field, the transverse and longitudinal modes of oscillation separate out. In the transverse part a coupled plasma oscillation occurs which could be propagated only above a certain critical frequency and in the longitudinal part one extraordinary mode of propagation occurs having a forbidden range of frequencies.

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When there is an external applied magnetic field, ordinary and extraordinary waves are propagated along the direction of the magnetic field, whereas only ordinary waves are propagated transverse to the magnetic field. The critical frequencies above which these waves are propagated are evaluated and the possible explanation of this medium like behaviour could be the implicit assumption of conductivity being not a scalar.

2. P. L. BHATNAGAR and C. DEVANATHAN (Bangalore) : *Generalized B-G-K Collision Model and Oscillations of a three-component Assembly.*

The BGK collision model for one component assembly of neutral particles has been extended to two component assembly of charged particles by Gross and Krook and later on modified by Bhatnagar. Following the lines of latter, the model has been generalized to N-component assembly of both charged and neutral particles. This model is further applied to the study of small amplitude plasma oscillations in an assembly consisting of ions, electrons and neutral particles in the direction perpendicular to a uniform magnetic field. The dispersion relation splits up into two, one determining the transverse oscillations and the other longitudinal oscillations. In the transverse oscillations for small wave numbers k, it has been shown that apart from the Gross gaps occurring at the multiples of gyrofrequencies of electrons and ions, if the magnetic energy density M is greater than one-third the kinetic energy density K of charged particles, and terms only upto k^2 are retained, five more forbidden ranges of frequencies occur. If $M<\frac{1}{3}$ K, the number of additional gaps reduces to three. When M=0, Oster's result is obtained as a particular case. The oscillations of neutral particles excited by collisions are strong at low frequencies, whereas for high frequencies they are mostly damped out. Longitudinal propagation has been studied under very restricted circumstance numerically and it is shown that, unless the magnetic field is very high, propagation is possible for all frequencies. For sufficiently high magnetic field when the Alfven velocity is comparable with the velocity of sound, there is one forbidden range.

3. A. J. DESSLER (Ahmedabad) : *Ionospheric Heating by Hydromagnetic Waves.*

The propagation of hydromagnetic waves through the magnetosphere and ionosphere has been studied in some detail. It is found that for wave frequencies above about 0·1 cps, a significant fraction of the wave energy is dissipated in the ionosphere below 300 km altitude. Some details of the hydromagnetic dissipation mechanism will be discussed and some possible consequences of hydromagnetic heating will be pointed out.

4. K. R. RAMANATHAN (Ahmedabad) :

K. R. Ramanathan presented the results of certain observations on electron density at high altitudes (from 10,000 to 50,000 kilometres) subsequent to the sudden commencement of magnetic storms and solar flares. A few hours (two to three) after the commencement, the electron density decreases rapidly as the altitude increases and in certain observations becomes practically nil (within the accuracy of the experiments). Immediately after electron density slowly increases and in almost all cases attains again its normal value in about two days. He further remarked that similar observations had been made from satellites orbiting at those altitudes and they confirm the same tendency.

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5. T. PRADHAN (Cuttack) : *Causality and the Dispersion Fodmulae for Waves in a Plasma.*

The principle of causality which states that the effect cannot precede the cause, is invoked to obtain the correct prescription for integrating across the pole in the dispersion formulae for the longitudinal and transverse waves in a collision-free plasma obtained by the simultaneous solution of Maxwell's electromagnetic and linearised Boltmann's transport equations. Conditions for growing and decaying waves are obtained from the results that follow from the above prescription. An analysis of the nature of the initial disturbance is also given.

6. R. K. RATHY (Kanpur) : *Steady Flow of a Conductivity Fluid in the Annular Space between two co-axial cylinders under transverse magnetic field.*

Hartmann's problem for a circular pipe has been investigated by Ya. S. Uflyand. In the present paper the steady fllow of a finitely conducting fluid in the annular space between two co-axial cylinders when one is moving parallel to its axis, under a transverse magnetic field is investigated. The velocity field is found to be symmetrical about the plane passing through the axis of the cylinders and parallel to the external magnetic field, while the walls are assumed to be non-coducting.

I. CONTROL OF ERRORS IN SAMPLE SURVEYS

Section of Statistics

Chairman : DR. C. CHANDRASEKARAN, Bombay.

1. M. A. TELANG (Bombay) : *Sampling and Non-Sampling Errors.*

There is need for proper supervision work over the collection of data for a sample survey. Provision should be made for well paid and qualified staff in the basic work of a survey organisation. Forms and schedules should be very carefully designed and drafted keeping in view the future processing of the collected data and realisation of the formulated objectives.

2. R. K. SOM (Calcutta) : *Control of Non-sampling Errors and Interpenetraling Sub-samples.*

Of the two types of errors, sampling and non-sampling, the sampling error is sought to be controlled by proper stratification and selection at different stages. The importance of the assessment and control of non-sampling errors, which may, and do, co-exist with sampling errors, has started to be recognized comparatively, recently. In data affected markedly by non-sampling biases, the sampling error alone would be a poor guide. It should, however, be emphasized that the chance and the magnitude of non-sampling errors are likely to be more in a complete enumeration ("censes"). In 1937, Mahalanobis introduced the technique of interpenetrating sub-samples (I.P.N.S.) in surveys conducted by the Indian Statistical Institute and this technique is now applied in the sample design of the National Sample Survey (NSS). The technique of I.P.N.S. enables one to separate out the investigator variance from the sampling errors (Mahalanobis,

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JRSS, 1946, Japan lectures 1958; Som, Sankhya (1962); NSS Report No. 48). A wider application in the control of errors by I.P.N.S. can be made in processing and also in bacteriological and X-Ray examinations in health surveys. Another control, also in the form of I.P.N.S., is built in the NSS and at present almost all the states participate in the NSS on a maching basis (Mahalanobis and Lahiri, Inter State Conf., 1960).

It is suggested that in a uni-purpose survey, the non-sampling errors would be easier to control and eliminate. This seems to be an irrelevant and misleading statement. All the surveys mentioned earlier, except the NSS, were uni-purpose surveys. In a uni-purpose demographic survey, the whole of the mortality data had to be rejected because of non-sampling errors! On the other hand, a multi-purpose survey may be preferred because of better utilization of scarce resource and better rapport with the people.

3. S. P. MUKHERJEE (Calcutta) : *Scrutiny of Working-Sheets by Control Charts.*

With manual tabulation, errors are likely to arise in the transcription of information on the questionnaire to the working sheet. To assess the accuracy, sample checks may be called for. An objective procedure has been suggested by which to judge from sample checks whether or not to examine an entire schedule for the case of m transcribers each working with a schedule containing k items of information for each of l units. The method consists in preparing a group control chart for fraction defective, each item being treated as a subgroup, the fraction defective being computed from a random sample of units. Varying numbers of units have been considered and the method extended to the case of a transcriber handling a number of questionnaires.

4. P. K. BOSE (Calcutta) : *Preventive Detection of Errors.*

Preventive detection of error is more important than cure or control of errors in sample surveys. It is good to work out rectification formulas or rules for cure of committed errors. But it is perhaps better to have vigilant team of workers posted in all important positions of a survey organisation. The workers of these levels should be well qualified and well paid.

5. K. V. RAMACHANDRAN (Bombay) : *Control of Non-sampling Errors in Sociological Surveys.*

Of the two broad groups of errors which enter into sample estimates the sampling errors and the non-sampling errors are important. Several techniques and methods are available to take care of the former whereas the non-sampling error, a part of the total error in the estimate, has received attention only recently. Several sources of non-sampling errors are enumerated; but we are here concerned with one type of non-sampling error which is usually important especially in large scale sociological type of enquiries and that is the personal error or bias introduced in sample surveys.

For a given cost if the sample size is increased the sampling error is reduced, whereas the non-sampling error is increased. Thus unless the budget is unlimited, in large scale inquiries especially of a sociological nature, the non-sampling error could play a very important role and the investigator error may play a very important part in it. Since different methods of sampling are available to take care of the different situations which will reduce the sampling error, part of the

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total error, the planner of surveys should design the survey in such a fashion that at least he may be able to estimate the interviewer differences and biases under certain conditions. Thus the detection of these errors should play an important part in the designing of a sample survey so that appropriate controls may be applied. The interpenetrating and interlocking method of sampling propounded by Prof. Mahalanobis to a certain extent take cognisance of the problem but the operating characteristics and other properties of the sampling methods should be investigated. Some work has been done at the Demographic Centre, Bombay, but more remains to be done.

6. LAKSHMI VENKATARAMAN (Bombay) : *How to Avoid Non-Sampling Errors.*

The only suggestion that I have to make is concerned with the control of the non-sampling errors. The extent to which the personal bias of the respondent, affects the information given by him—this is one of the sources of non-sampling errors—could be reduced by modifying the method by which this information is obtained from the respondent. Take the case study of a readership survey conducted in the U.S.A. where an obviously inflated figure was obtained for "respectable" magazines like Life, Fortune, etc. Whereas readership figures for magazines like Romances, True Confessions, etc., were very much under estimated. Here the method of getting the required information was improved by requesting the housewives to give all the old magazines in the house. So that they could be used in a charitable institution and thus finding out as to what magazines are actually brought in the house. This would be a better technique which will give a more accurate picture of what magazines are actually bought. Thus refinement of schedule design and method by which information is obtained is an important area whereby non-sampling errors could be controlled.

7. P. K. PATHAK (Calcutta) : *Simple Random Sampling.*

In simple random sampling with replacement Basu (1958), and Des Raj and Khamis (1958) have shown that for estimating the population mean, the average of distinct units is more efficient than the overall sample mean. In this paper, a detailed treatment of the above problem is given, and an estimator has been found which has smaller variance than the well-known Horvitz-Thompson estimator. Some unbiassed estimators are suggested and their relative performance is studied with the help of a numerical example. An improved estimator of the population variance is also derived. Lastly, a comparison between the two simple random sampling schemes (with and without replacement) is made for the purpose of estimating the population mean.

8. N. K. D. CHAUDHURY (Roorkee) : *Estimation of Unreported Births and Deaths.*

The estimation of the unreported deaths and births is an important problem. If good estimates were found, the figures could be used for checking the comparability of two consecutive census estimates.

9. V. V. B. RAO (Bombay) : *Personal Bias in Sample Surveys.*

Apart from the recall error from the informant's side in non-sampling errors, there is the informant's personal bias. The model used for recall errors, for

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example, cannot be used in the case of sex Ratio errors. Because this error arises out of informant's personal bias, one cannot say that the under-enumeration of the females is not an aspect of re-call error but informant's personal bias. Perhaps, one way of controlling this error is convincing and educating the people in the ways of surveys.

10. S. R. KULKARNI (Dharwar) : *People's Co-operation in Sample Surveys.*

There should be a proper education programme for the respondents of a survey. People should be made to understand all the various purposes of the survey, and this is by far the best way of controlling the non-sampling errors.

11. R. GIRI (Delhi) : *Wastage of Resources in Sample Surveys.*

Crowding of the schedules with numerous items in multi-purpose surveys contribute to large non-sampling errors. This leads to unreliability of the results obtained. Even a multi-purpose survey should not be so 'multi-purpose' that a particular group of investigators with their limited knowledge and experience and training might not be in a position to do justice to all the items. In multi-purpose survey in which items occur frequently are usually estimated with much larger precision than needed, and items with low frequency, with high sampling error. This one should consider as wastage of resources.

12. A. P. BHATTACHARYYA (Roorkee) : *Respondent Bias in Sample Surveys.*

Some inaccuracies inherent in the standard methods employed in sample surveys in the form of eliciting information by replies to questionnaires are worth noting. An example may be given from the results of an analysis of benefits of a canal irrigation in the commanded area of a major canal system of Uttar Pradesh (Sarda Canal System). A sample survey was conducted by the Economics Department of the Lucknow University. It was found that 97% of the cultivators had replied that high irrigation rates were impeding the development of canal irrigation, while 99% had replied that inefficiency was the main cause. Obviously the results had to be judged with caution and the element of bias in the above mentioned replies could not be ruled out.

II. NUMERICAL ANALYSIS AND MODERN COMPUTING DEVICES

(Jointly with Sections of Mathematics, and Engineering and Metallurgical Sciences)

Chairman : DR. P. L. BHATNAGAR, Bangalore.

1. L. K. WADHWA (New Delhi) : *Simulation of Third Order Systems with One Operational Amplifier.*

The third order linear system simulation by electronic analog computers is generally done with two or more operational amplifiers by techniques that are very well known.

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A method has been discussed in this paper which shows that third order linear systems can be simulated with the aid of only one operational amplifier and a few two-terminal impedance consisting of resistors and capacitors only.

Three possible circuits capable of simulating a particular case of the general third order linear system have been presented and the resulting third and fourth order non-linear algebraic equations have been solved for determining the validity conditions and the circuit component values.

The method of simulation is simple. If the validity conditions are satisfied then a physically realizable network consisting of one operational amplifier, three capacitors, five resistors exists and the component value may be easily calculated from the equations developed in the text.

2. L. K. WADHWA and JAGDISH CHANDRA (New Delhi) : *One Operational Amplifier Simulator for a Third Order System with a Leading Time-Constant.*

In another paper presented in this symposium one particular case of a general third order system was considered. In this paper another case of the general third order linear system with one leading time-constant is considered.

Only three of the possible sixteen circuits are discussed in the text. The circuits given in the text have been analysed and the resulting third degree non-linear algebraic equations have been solved with a view to determining the validity conditions and the component values.

The method of simulation is simple. If the validity conditions are satisfied then a physically realisable network consisting of one operational amplifier, four capacitors and four resistors exists and its component values may be easily calculated from the equations developed in the text.

3. P. K. BOSE (Calcutta) : *Time Honoured Techniques of Computation.*

There is no doubt a strong need for development of computer equipments in various centres of scientific and technological research in our country, but the workers should not forget the time honoured methods, particularly in cases where their data are of manageable size. Individual researchers should always make it a point to master some of the standard techniques known so far to be quite suited to manual computing machines. Before the modern computer devices are taken into use, the workers should make a thorough study of their limitations. Good points of results obtained through relaxation or incomplete integral equation methods should be taken into consideration.

III. STATISTICAL METHODS IN MEDICAL SCIENCES

(Jointly with Section of Medical and Veterinary Sciences)

Chairman : DR. J. C. BANERJEA, Calcutta.

1. K. K. MATHEN (Calcutta) : *Statistical Methods in Medical Sciences.*

In taking up the subject of drawing inferences from statistical data collected we may think of two kinds of situations. On the one hand, the investigator wishes to know whether the statistics he has collected are compatible with certain theories he had with regard to the true state of affairs. On the other hand, the

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public health worker or clinician has to make certain decisions such as stopping a clinical trial because the results achieved are too poor to justify its continuation or to decide whether the patient at a certain stage of the disease should be operated or not taking into account the risks involved. In either case the doctor's decision is associated with elements of risk. An essential function of statistical methods is to measure this uncertainty and in order to fortify statistical inference in such situations the Theory of Probability has been developed and utilized by the statistician.

We may state here some of the important uses of sampling technique in the medical and public health fields. It is well known that study of a sample is more economical than a complete study of the population. Generally, it is more speedy. But a less well recognized advantage of sampling method is that in many instances complete study or enumeration of the population is not only less accurate than the sample study but even impracticable. A very good example from clinical medicine of the impossibility of a complete study of the population is the laboratory diagnosis of a patient based on the examination of a few drops of blood. The procedure is based on the assumption that the circulating blood is always well mixed and that one drop tells the same story as another. Other good examples in public health practice are the sample examination of food produced in an establishment of milk produced in a dairy and the sample examination of water in a water supply plant.

To test whether the evidence from two independent samples relating to two treatments suggests that the treatments have different effects, we assume the opposite proposition to hold viz. that the two treatments have the same effect. Using probability and sampling theory we calculate the probability for obtaining results noted. If this probability is smaller than a standard level (chosen according to the situation) then following the 'Reduction to Improbability' argument, we reject the hypothesis.

2. V. N. AMBLE (Delhi) : *Statistical Methods in Animal Sciences.*

Applications of statistical theory and methods to animal research particularly with large animals are varied and interesting involving as they do both experimental and survey situations and presenting at the same time a number of complications owing to factors such as considerable animal to animal variation, a low reproduction rate, long generation interval, limited availability of experimental material etc. The applications may be conveniently divided into those concerning (i) animal genetics and breeding, (ii) animal nutrition and management problems, (iii) problems concerning control of animal diseases and pests, (iv) standardisation of procedures of sampling and measurement techniques and (v) estimation surveys for assessment of existing situation and progress.

In many fields of animal experimentation sampling has to be resorted to for securing the required data. For example the estimation of milk production in a village cattle development scheme can only be done on the basis of records of milkyields on a sample of days during the lactation of a selected sample of animals in milk in the population under the scheme. Similarly in any research on wool improvement, a sound procedure for sampling the fleece is necessary for assessing the quality attributes of wool. Statistical techniques are not only necessary in developing suitable sampling procedures but also in further standardisation of procedures of measurement of diameter, fleece density, etc.

Finally statistical techniques are needed in conducting surveys for assessment of existing situation of progress. The I.A.R.S. has been engaged of late in developing random sampling techniques for estimation of livestock numbers, amount of marine fish catch and livestock products such as milk, wool and eggs. The

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Institute has also evolved a technique for estimation of cost of production of milk and carried out surveys for the purpose in Delhi, Madras and Calcutta. The statistical assessment of the progress of rinderpest eradication campaign undertaken by the Government of India on a countrywide scale well illustrates the role a statistician can play in controlling the operational efficiency of a large scale programme.

3. A. B. L. SRIVASTAVA (Meerut) : *Statistical Approach to Medical Diagnosis.*

A medical diagnosis does not in general represent a hard fact; it only represent a physician's judgment and opinion. As such it has been felt necessary to use only objective measures of patient function such as temperature, blood pressure, X-Rays etc. for diagnosis. It makes a mathematical approach to the problem possible.

Two Models that realistically represent the processes actually employed by the physicians in diagnosing disease have been suggested. (i) *Discriminant function model*—Each sign or symptom is given an empirically derived weight and a single artificial mathematical measure is obtained as the sum of separate weighted values. (ii) *Frequency count model*—The relative frequency of occurrence of each possible symptom-disease pattern is considered. Electronic computers can be programmed and worked to determine the most appropriate diagnosis in a certain case by making use of the factual data relating to a patient's symptoms. The methods used in certain studies made in American Institutions show how the propositional calculus can be employed to work out symptom—disease complexes, from which in a logical way the disease can be diagnised.

4. A. K. GAYEN (Kharagpur) : *Need for Facilities of Studies and Research in Medical and Bio-Statistics.*

Our research laboratories should develop Divisions of Statistics to deal with application of mathematical and statistical methods in various branches of medicines and biology and other allied science. Researches in (i) Epidemiology and Aetiology of disease, (ii) Design and analysis of therapeutic trials and new drugs and other agents, (iii) Field trials of prophylactic agents, (iv) Experimental methods in biological assay etc. will come in its purview. Such Divisions should be entrusted with the collaborative work in problems of a statistical and observational nature that are encountered by the research workers belonging to all the various allied fields of Medical and Biological research.

The science of Statistics is rather of recent origin. All its important developments were made in the first few decades of this century. The literature that have grown specially on the problems of Medicines and Biological Sciences, tackled with mathematical and statistical tools, are of fairly high standard and are largely the contributions of workers (Statisticians) attached to high grade medical research Institutes of Western countries. We have to work hard and devote considerable attention to keep abreast with the up-to-date development of techniques and tools of research, to be able to produce results of real value in the field. Every effort must be made to utilise the resources that are available here to build up a body of workers to shoulder the responsibility of organising researches and investigations in the field and to see that the level of efficiency of the activity and the standard of contribution compare well enough with those of the other advanced countries of the world.

Research workers in the field of medical statistics have found so far the concepts and tools of the most important branches of Sciences, viz. Physics and Chemistry, very useful in their investigations. But to-day the usefulness of Statistics

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in their work is perhaps stronger because, the past few decades have found development in Physics and Chemistry themselves to be much dependent on the theory and practice of Statistics, a comparatively new scientific discipline. Whether we like it or not, once a Science advances beyond the descriptive stage, its problems become somewhat statistical. As the application of concepts and tools of Physics and Chemistry in the study of Biological and Medical investigations have resulted in the development of two somewhat distinct branches of applied Science, viz., Biochemistry and Biophysics, so the applications of modern statistical ideas and techniques have contributed towards the building up of another very useful branch of applied science, viz., Bio-statistics.

5. DR. B. MUKHERJEE, the General President of the Congress, attended the symposium, and made a strong plea for active cooperation of workers of Biological Sciences and Mathematics and Statistics. He dwelt on the quantitative aspects of the present day investigations in pharmacology and biology and the fruitful uses of statistical methods.

RADIO AND MICROWAVE SPECTROSCOPY

Section of Physics.

Chairman : PROF. VIKRAM A. SARABHAI, Ahmedabad.

1. D. V. G. L. NARASIMHA RAO (Waltair) : *Electron spin resonance in Gamma Irradiated single crystals of some Organic Compounds.**

A study of the electron spin resonance spectra is now an established method for investigating the free radicals produced by x- or gamma irradiation. A large number of organic chemicals has been investigated in the powder form at room temperature as well as at low temperatures. Though the free radicals induced by the radiation can sometimes be identified, there is always an uncertainty in the conclusions drawn due to the anisotropy in the g- factor or the nuclear hyperfine coupling constant. On the other hand, by investigating the spectra of the sample in the form of a single crystal, one can obtain more information about the anisotropics in the g- value and the hyperfine splittings. Further, conclusions regarding the nature of the radiation induced free radical will be more reliable. The importance of such investigations has been realised only recently and already results on a few single crystals have been reported by McConnell, Gordy, Whiffen and others.

Detailed analysis in the case of urea oxalate, DL-tartaric acid and its deuterated derivative, for which the author has carried out measurements at X (9 kmc/s) and K (23 kmc/s) bands for all orientations in the external magnetic field, will be presented. In both the cases weak lines due to second order transitions corresponding to the simultaneous flipping of the electron and the nuclear spin of the hydrogen have been detected and could be explained theoretically.

2. DR. C. N. R. RAO (Bangalore) : *Chemical Applications of nmr Spectroscopy.*

Applications of nuclear magnetic resonance spectroscopy in the elucidation of structures of compounds particularly, natural products, in the study of hydrogen bonding, in the study of conformational equilibria in cyclohexane derivatives, and in reaction kinetics will be reviewed.

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* Work performed in the Microwave and Radiofrequency Laboratory, Duke University, Durham, N.C., U.S.A.

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3. B. VENKATARAMAN (Bombay) : *Hyperfine Structure Investigations in Electron Spin Resonance of Organic Free Radicals.*

Proton hyperfine structure observed in the ESR of organic free radicals containing π-type odd electron system has been the subject of investigation by several workers. The experimental results obtained and the information they have given regarding the structure of these free radicals are briefly discussed. Satisfactory theories have been proposed to explain these experimental results and the latest theories attempt to give the value of the density of the unpaired electron at the ring-carbon of an aromatic free radical. The experimental results obtained on C^{13}-labelled compounds and also on C^{13} in natural abundance, will be presented.

4. P. PARIKH (Gujarat) : *Dynamic Nuclear Polarisation in free Radical Solution.*

The method of dynamic nuclear polarisation (as first suggested by Overhauser[1]) is employed to enhance the weak nuclear signals available in very low magnetic fields. The interactions studied in these experiments were of the dipol-dipol type which existed between the free electrons of the radical and the protons of the solvent substance. In case of an aqueous solution of the free radical $(SO_3)_2No.$-- the enhancements of the proton signals on simultaneously exciting the electron resonance of one of the eight possible hyperfine structure transitions are studied in very low magnetic fields (between 0·3 Oe to 20 Oe). The method also allows a study of the nature of the interaction between the free electrons of the dissolved Asphaltene radical and protons of the surrounding lighter hydrocarbons of the liquid in natural crude oil.

The apparatus is capable of registering the nuclear magnetic resonance signals with and without the enhancement by the effect of dynamic polarisation. The required sensitivity is achieved by employing a modified Q-meter[3]) along with phase sensitive detection where rapid-field modulation method is applied. Precise measurements of low magnetic fields could be made and a nuclear magnetic resonance MASER* could be operated in the whole range of the magnetic fields.

5. V. SUBBA RAO (Andhra University) : *Some Applications of Molecular Beams.*

This paper is primarily concerned with the applications of the technique of molecular beams to determine certain magnetic properties of complex molecules, such as the mean magnetic moment of the complex. Making use of their deflection properties in inhomogeneous magnetic fields, values have been obtained for dissociation energies of these complexes into their two basic components.

Alkali halides, when heated together with divalent halides of Fe, Co, Ni form complexes of the type $KClFeCl_2$. The complex is the dominant detectable species by the positive ion detector, which is invariably used in all the magnetic machines, in the vapour phase. These complexes are characterised by virtue of their mean magnetic dipole moments which are much larger than the nuclear magneton and much less than the Bohr magneton while the alkali halide has a very small magnetic moment of the order of a nuclear magneton.

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[1] A. Overhauser, Phy. RW., *92,* 411 (1953).
[2] W. Miller-Warmuth and P. Parikh, Bulletin Ampere, *9,* 680 (1960).
[3] W. Miller-Warmuth ahd P. Servoz-Gavin, F. F. Naturforsch, *13a,* 194 (1958).
* MASER—An acronym for Microwave Amplification by Stimulated Emission of Radiation.

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6. DR. S. S. SRIVASTAVA (New Delhi) : *Rotation Spectra of Long Chain Molecules in Radio and Micro Wave Band.*

The rotational spectra of Phthalates has been observed in Radio and Micro Wave Band by determining the distribution of dielectric loss with frequency extending over a band of 100×10^6 c.p.s. to $2{\cdot}64 \times 10^{10}$ c.p.s. The absorption has been measured in several non-polar solvents by specially designed cavity resonators. The tan δ – log f closely fits in with the theoretical curve tan $\delta = {\cdot}00857$ Sech log fm/f with a maximum at a frequency $3{\cdot}29 \times 10^9$ c.p.s. which is considered to be due to the rotation of the molecule around its longitudinal axis since symmetry of the molecules along the horizontal rules out such movement. The paper presents measurements carried out in radio and micro wave band on a number of long chain molecules.

7. DR. (MISS) P. R. K. L. PADMINI (Visakhapatnam) : *Study of Ultrasonic velocity dispersion and absorption in High Polymer solutions.*

Ultrasonic velocity studies are carried out in organic solutions of various fractionated samples of polyvinyl acetate, cellulose acetate and Ethyl Cellulose. The parameters adiabatic compressibility, apparent molal compressibility and apparent molal volumes are calculated and their variation with concentration and molecular weight is studied. Dispersion of ultrasonic velocity is studied in Benzene solutions of four fractionated samples of polyvinyl acetate and acetene solutions of three fractionated samples of Cellulose Acetate. A velocity dispersion of 100 m/s in polyvinyl acetate solutions, and a dispersion of 25 m/s in cellulose acetate solutions is observed in the frequency range 1 to 5 mc/sec. Absorption studied are carried out in Benzene and Acetene solutions of unfractionated and fractionated samples of polyvinyl acetate and unfractionated sample of cellulose acetate. The results are interpreted in the light of the existing theories of absorption.

I. CYTOGENETICS OF POLYPLOIDS

Section of Botany

Chairman : PROF. J. VENKATESWARLU, Waltair.

1. P. N. MEHRA (Chandigarh) : *Polypoloidy and Evolution.*

Information has been presented on the incidence of polyploidy in different groups of land plants. Ferns show the maximum polyploid percentage being of the order of 45·4% amongst the investigated taxa. Certain genera and groups like *Selaginella,* members of the Osmundaceae, Anthocerotales, Cycads and Conifers are averse to polyploidy. It is suggested that they lack the inherent potentiality or genetic fit to bear the load of polyploidy for the maintenance of their physiologic efficiency and survival in nature. Their normal chromosomal set is already in a state of saturation within the cytoplasm in which they are lodged for their maximum efficiency unless in exceptional circumstances when a particular genetic combination of a multiple set may override this general effect. The cytogenetical factors operating in the evolution of taxa of different categories are identical in different plant groups. Autoploidy though distinctly operative is much less potent than segmental polyploidy or alloploidy in differentiation of species. The role of

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alloploidy in conjunction with chromosomal alterations including gene mutations, particularly at the dibasic level, in differentiation of taxonomic categories above the species level seems to be much more than so far realised as deduced from circumstantial evidence. The geographical significance of frequency of polyploidy has been considered in its wider perspective in terms of different factors like age, intrinsic potentialities, breeding mechanisms, opening of new niches etc. in different plant groups. In ferns the rate of polyploid evolution is faster in tropics than elsewhere. In other Pteridophytes, which are also inhabitant of tropics, the degree of polyploid evolution achieved is much higher than in any other group of plants because of their age.

2. E. K. JANAKIAMMAL (Jammu-Tawi) : *Polyploidy in Relation to Adoption and Extension of Habitats.*

A comparative study of chromosome numbers of the families of flowering plants, shows that the prevailing basic numbers in many "Natural Orders" are allopolyploid derivatives of smaller complementary chromosome complexes found in related families. The ancestral chromosome relationship is sometimes preserved by the survival of a few genera with these numbers in families like Loganeaceae.

It is thus very probable that families originated in definite are as by hybridization followed by chromosome duplication, and spread rapidly over the earth during geologic periods when the climate was more equable and the surface flatter than it is to-day.

With the advent of eras of mountain building which was followed by glaciation and later by desert conditions many species became extinct while others withstood environmental changes by chromosome changes involving polyploidy. Both auto- and allo-polyploids show differences in morphology from their diploid progenitors. These differences can give the polyploid ecological advantages over the diploid allowing the polyploid to replace the diploid as well as to colonize. New climatic and edaphic situations free from competition. With the retreat of ice in the Northern Hemisphere, species, isolated, have been brought together for further hybridization and polyploidy and in this way a new era of polyploidy initiated in specific regions, chiefly peripheral areas of the diploid. This has been the case in such genera as *Primula, Rosa* and many others in which polyploids have migrated latitudinally from their ancestral homes.

In Rhododendrons the new polyploid as a result of physiological benefits derived by polyploidy have come to occupy altitudes that no other flowering plants have attained on the Himalayas.

A detailed analysis of the relationship between altitude and polyploidy in species of Rhododendron is presented.

3. M. S. SWAMINATHAN (New Delhi) : *Cytogenetic Mechanisms involved in the Diversification and Stabilisation of Polyploids.*

The polyploid plants occurring in nature represent a continuous spectrum of variability in their cytogenetic properties, ranging from inter-varietal autopolyploidy to strict genomic allopolyploidy. A vast proportion of polyploids occupy an intermediate position between these two contrasting categories. This is natural since a combination of the desirable features of autopolyploidy (i.e., polysomic constitution at loci showing additive effect) and genomic allopolyploidy (i.e., regular meiosis) would confer the maximum advantage to the plant. The extent to which this process has proceeded in different plants varies depending upon the type of natural and human selection that have been in operation and the scope available for subsequent hybridization and introgression.

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The genetic stability of a polyploid can be achieved through either apomixis (including vegetative propagation as in the case of *Solanum tuberosum, Ipomoea batatas* etc.) or mechanisms designed to ensure cytological diploidy. To the latter class belongs the very interesting recent discovery of the operation of a multivalent suppressor gene system in *Triticum aestivum* and the various modes of configurational regularisation of chromosome disjunction. Extensive chromosome re-patterning and chromatin elimination also take place in polyploids contributing to morphological diversity and genetic diploidisation.

Besides introgression which is an important factor in the diversification of polyploids, polyploidy provides the wherewithal to withstand the occurrence of macro-mutations, which at a single step may lead to the origin of supra-specific taxonomic categories. Macro-mutations, which are seldom viable in diploids, survive more readily in polyploids and their role in engendering new variability should be critically assessed.

A comparative study of naturally occurring and synthetic allopolyploids shows that while even apparently worthless genomes combine to produce a superior genotype in the former category, most new synthetic genome combinations prove to be unstable and inviable. This illustrates that coherence rather than individual merits contributes to the stability and adaptive virtues of an allopolyploid.

4. K. N. NARAYAN (Mysore) : *Apomixis and Polyploidy.*

Recent reports have revealed that more than 200 species of angiosperms reproduce by means of apomixis. Of these 200 or more species, Gramineae alone has about 86 and Compositae comes next with about 65 forms. A large number of these apomicts are polyploids, a fact which indicates that there is a close association between apomixis and polyploidy. Such an association of apomixis and polyploidy has prompted some authors to postulate that polyploidy initiates apomixis. Although evidence for such a view is not very convincing there is evidence to show that polyploidy stabilises and promotes apomixis.

Adventitious embryony is the one type of apomixis that is more commonly seen in the diploids, while gametophytic apomixis is very rarely seen in them. Stebbins mentions only three groups of diploid plants with gametophytic apomixis viz.—*Potentilla, Ranunculus* and *Heiracium.* Among grasses only one diploid, *Pennisetum ramosum* 2n=10, was known to exhibit a tendency towards apospory. In recent years two more diploid grasses *Pennisetum hohenackeri* 2n=18 and *Panicum antidotale* 2n=18 have been shown to be aposporous. The latter has two forms, a diploid with 2n=18 and a tetraploid with 2n=36. Apospory seen in these two forms is interesting in that in the diploid it is of a low frequency while in the tetraploid it shows a high frequency. In addition the tetraploid is also diplosporous. This relation of an increasing degree of apomixis with an increasing degree of polyploidy supports the view that the action of genes producing apomixis is more pronounced at the polyploid level than at the diploid level. Good evidence for such a relation between polyploidy and apomixis is available in ferns and in some viviparous angiosperms.

5. S. V. S. SHASTRY (New Delhi) : *Secondary Polyploidy—Occurrence, Detection, and Significance.*

Difficulties encountered in the classification of polyploids are due to the variable primary unit of evolutionary change which may be a genome, a chromosome or a chromosomal segment. Secondary polyploids owe their origin to extra dupli-

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cation of one or more chromosomes in one or more genomes of a polyploid and are a wide occurrence in angiosperms. The detection of chromosome number which is not a multiple of the basic number by itself does not constitute an evidence for secondary polyploidy since the fragmentation and fusion of chromosomes could lead to the above effects. Since the phenotypic characters of the organism not only depend upon the sum total of genes, but also upon the balance between the genes with opposing action, strict secondary polyploids are likely to affect the balance while the "apparent secondary" polyploids (fusion and fragmentation products) may not do so. Extensive occurrence of this type of polyploidy indicates that at least a small part of these changes which occur in nature are adaptive, are favoured by natural selection and constitute a progressive force in evolution.

The standard methods of detection of secondary polyploidy are by the study of chromosome numbers, secondary association, autosyndetic pairing in haploids and interspecific hybrids, and increase in the number of bivalents and trivalents in a triploid hybrid. Every one of these methods have their own limitations. Chromosome structural changes in some cases mimic the secondary polyploidy. Genetic evidence of polysomic segregation in functional diploid organisms constitutes an independent evidence but even this criterion sometimes is misleading, since chromosome structural hybridity by way of cryptic differentiation can lead to wide disturbances in genetic ratios which might be wrongly interpreted as due to polysomic inheritance. In view of the above limitations in the methods of detection, independent and corroborative evidence from as many different methods as possible might constitute a reasonable proof of secondary polyploidy. The reported cases will be critically evaluated from this stand point.

6 R. P. ROY (Patna) : *Genomic Studies in some Triticum-Aegilops Amphidiploids.*

In this discussion is included the behaviour of only a few of the amphidiploids involving some species of the genera *Triticum* and *Aegilops* with a view to throw some light on the genomic nature of the species concerned. The amphidiploid *T. aegilopoides* X *A. bicornis* is particularly useful from this point of view. It is generally held that species whose genomes are dissimilar show no pairing of chromosomes in F_1 hybrids but normal bivalent formation in the derived amphidiploids. Integeneric F_1 hybrids and amphidiploids normally satisfy these criteria. Yet in the genera *Aegilops* and *Triticum,* there are F_1 hybrids which always show some amount of chromosome pairing, but the derived amphidiploids have only bivalents and possess normal fertility confirming the Darlington's Concept of "preferential pairing". In the *T. aegilopoides* X *A. bicornis* there are ring bivalents in F_1 and high percentage of PMCs show quadrivalents in the derived amphidiploid. It may be remembered that the genome of *T. aegilopoides* being AA, (this species is considered to be the donor of A genome to the tetraploid and hexaploid wheat) is quite dissimilar to the genome S^bS^b of *A. bicornis* (this species is closely related to *A. speltoides,* another member of the Sitopsis group, the latter is looked upon as the donor of the B genome to the bread wheats) and yet some chromosomes do show close pairing as indicated by ring bivalent in F_1 hybrids mentioned above. In the derived amphidiploid several types of multivalents, such as, ring, zig-zag, figure of eight etc. are found. In spite of this, the fertility of this amphidiploid is as high as that of those plants where there is no multivalent at all. It is obvious from the configurations of the multivalents (microphotographs shown) that several of them cannot segregate regularly and would, therefore, give rise to unbalanced gametes. The normal fertility of this plant may, therefore, be due to compensation mechanism present in these species, as also reported between *T. aegiloploides* and *A. squarrosa* by Sears (1939). The chromosome pairing in the

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F_1 hybrid further indicates that allelic genes on the chromosomes of the two species are present. This may be interpreted to mean that species of the two genera have evolved from a common stock and although the chromosomes in them have undergone modifications, yet there are segments which are similar. Secondly, it may also mean that there occurs frequently a flow of genes from one species to the other and thus absolute sexual barrier has not yet been established between them.

There is another group of hybrids and amphidiploids involving the diploid species *A. speltoides* and several species of tetraploid wheats. This group is particularly interesting because Stebbins (1959) and Riley *et al* (1958) have concluded that B genome of the tetraploid and hexaploid wheats has been donated by *A. speltoides* and not by *Agropyron* species as held by earlier workers. The F_1 hybrids in this group show very high degree of chromosome pairing indicating that the genome of *A. speltoides* is similar to one of the genome of tetraploid wheat. The derived amphidiploids are very unstable and show high frequency of multivalents. The different plants are quite dissimilar in their morphological characters indicating that because of irregular distribution of chromosome, gametes of different constitutions are formed. The main point of interest is that the F_1 and amphidiploid studies in this group clearly prove the close homology of a set of chromosomes of the tetraploid wheat with those of *A. speltoides*.

It may, therefore, be concluded that the genera *Triticum* and *Aegilops* are much more closely related than the other genera of the sub-tribe *Triticeanae*. In the revolutionary scale, these two genera appear to have separated much later than other genera of this order.

7. A. T. NATARAJAN (New Delhi) : *Polyploidy and Radiosensitivity.*

An understanding of the role of polyploidy on the rediosensitivity of cells has attracted the attention of many workers in view of its bearings in both fundamental and applied fields : (a) From agricultural point of view (in induction of beneficial mutations) it is of interest since many of the important crop plants like wheat, cotton and potatoes are of polyploid origin, (b) from medical point of view, in radiation therapy of cancer, it is of interest since malignant tumorous tissues comprise mostly of polyploid and aneuploid cells, (e) from radiobiological point of view it is of interest in understanding the resistance of certain adult tissues in comparison to young ones to radiation, which may be due in part to the highly polyploid nature of otherwise radiosensitive tissues, like liver tissues and (d) in understanding the mode of biological action of different types of radiations, since *polyploidy* is the only factor known to influence response to densely ionizing radiations.

The results obtained, in general, suggest that the radiation induced lethality decreases with an increase in ploidy. This is amply illustrated by *Sparrow* and co-workers, from their study of tolerance to chronic gama irradiation of two polyploid series—Genus *Chrysanthemum* (Compositae, with 2n=18, 36, 72, 90 and 198) and *Sedum* (Crassulaceae, with 2n=20, 28, 30, 34, 44, 48, 50, 54 and 58). More detailed study of differential response between diploids and polyploids, including immediate growth response, somatic and gametic cytological changes as well as incidence of mutations in X_2 and X_3 generations has been made by *Swaminathan* and his associates in different types of polyploids like barley (diploid and colchicine induced tetraploid), wheat (diploid, tetraploid and hexaploid—different species and allied genera—of allopolyploid origin), cotton (diploid and tetraploid—an amphidiploid by origin) and *Sorghum* (diploid and tetraploid—the tetraploid having higher chromosome number (2n=20) with lesser total chromosome length and DNA con-

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tent in comparison to diploids). While these studies supports the general theme of resistance of poloyploids to radiation, interesting information with regard to the bearing of chromosome number, chromosome length, DNA content, the type of polyploidy, the interaction of genomes in allopolyploids as well as the impact of LET (linear energy transfer) towards the understanding of the role of polyploidy in relation to radiation response and how best radiations can be used to harness mutations with efficiency has been obtained. In yeast, in which detailed studies have been made with regard to survival following radiations, in haploid, diploid and polyploids confirm the higher resistance of polyploids, though the mechanism involved is not clear. The studies on *Habrobracon* (haploids and diploids) have shown that the degree of resistance of diploids in comparison to haploids varies according to the developmental stage in which the wasps are irradiated.

The general implications of the results obtained in these studies will be discussed.

8. G. PANIGRAHI and S. N. PATNAIK (Shillong) : *Polyploidy in Polypodiaceae—Its Evolutionary and Adaptive Significance.*

The family Polypodiaceae represented by 21 genera and 106 species in India, occurs mostly as epiphytes on tree trunks or on humus-covered rock boulders in the tropical and subtropical evergreen forests although *Dipteris wallichii* as its only terrestrial Indian species, is restricted to Eastern India. An analysis of the cytological data available from 70 species belonging to 22 genera studied upto date shows that only 8 species are tetraploids whereas two others have attained hexaploidy only, all the remaining diploid species being characterised by a range of aneuploid base numbers varying between x=11 to x=47.

Thus, the low percentage (14%) and very low grade of euploidy in the predominantly tropical family Polypodiaceae are contrary to expectations. But the discovery of tetraploidy (viz. n=66) in the most primitive terrestrial species *Dipteris wallichii* and limitation of the evolutionary potential of euploidy to only species formation viz. in *Loxogramme, Pyrrosia, Lepisorus, Leptochilus* and *Polypodium,* have been utilised to suggest that epiphytic habit inside the closed evergreen forest canopy serves as a "bottle neck" to euploidy whereas terrestrial habit in identical situations may provide the necessary stimulus to the induction of euploidy.

Discovery of an astonishing array of haploid numbers in *Lepisorus* viz. x=13, 22, 23, 35, 36, 37 and 47 and of x=36 in 13 other genera postulated by contemporary taxonomists to have originated from *Lepisorus*-like ancestors on the basis of evidences from comparative morphology, establish *Lepisorus* as a highly potential "evolutionary plexus". The evolution of genera with x=35 and x=37 is explained by the aneuploid loss or gain of one pair of chromosomes. The formation of chains, variable number multivalents, bivalents and univalents in *Lepisorus pseudonudus* with 2n=39 and the formation of 35 bivalents and one tetravalent or 35 bivalents and 4 univalents, or 36 bivalents and two univalents in different cells of *Drynaria quercifolia* with n=37 from Garo Hills, confirms the dominant role played by structural translocations in the origin of aneuploid base numbers in the family. The finding of so low base numbers as x=11 or 13 in *Lepisorus* point to the haploid numbers viz. x=33, 35, 36, 37, 47 etc. as tips of a divergent polyploid series. Thus, the aneuploid base numbers may be postulated to have acted as an "evolutionary pool" and thus, to have played the major role in the evolution and adaptation of the family Polypodiaceae to the peculiar "mid-air" habitats available to its members within the tropical and subtropical evergreen forests.

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II. EVOLUTIONARY TRENDS IN GYMNOSPERMS

Chairman : PROF. J. VENKATESWARLU, Waltair.

1. P. MAHESHWARI (Delhi) : *The Evolution of the Archegonium in Gymnosperms.*

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There is a considerable range of variation in the number of archegonia in gymnosperms. *Torreya taxifolia* and *Acmopyle pancheri* have a singe archegonium per ovule while in *Microcycas* and *Widdringtonia juniperoides* the number may go up to 200.

The families Taxodiaceae and Cupressaceae show a complex of archegonia surrounded by a common jacket. Such a condition also occurs sporadically in other gymnosperms and must be considered as more advanced than that of separate archegonia, each with its own jacket.

While the archegonia are normally apical, they are regularly of the lateral type in *Widdringtonia, Callitris, Sequoia* and certain other genera. Most of them develop around the terminal swollen part of the pollen tube which grows along the female gametophyte for a considerable distance. Archegonia in abnormal positions have also been seen in *Pinus, Cedrus* and *Ephedra,* and this is probably a derived condition. In the fossil gymnosperm archegonia have been observed only at the apical end and do not form a complex.

A definite ventral canal cell is seen only in *Ginkgo* and the Pinaceae; in the other gymnosperms only a ventral canal nucleus is seen. Even this may be absent in some Taxodiaceae and Taxaceae. There is thus a positive tendency towards the elimination of the ventral canal cell and the functioning of the central cell directly as the egg. Rarely, as in *Ephedra,* the ventral canal nucleus may also become fertilized but this bears no relation with the double fertilization in angiosperms.

The neck is four-celled in most genera but comprises 30-40 cells in *Ephedra* which merely illustrates that evolution may not take place at the same rate in all directions.

In *Welwitschia* and *Gnetum* there are no archegonia. In the former certain unspecialized cells in the upper part of the female gametophyte form the so-called embryo sac tubes. In *Gnetum* a few nuclei in the upper part of the gametophyte differentiate into egg cells under the stimulus of the pollen tube.

The gymnosperms show an approach to the angiosperms because of the reduction of the archegonium and its eventual disappearance but provide no clue to the origin of double fertilization. Unfortunately we have no knowledge of the reproductive structures of either the fossil gymnosperms or the fossil angiosperms.

2. K. R. SURANGE (Lucknow) : *"Evolution in Gymnosperms—Recent Fossil Evidences".*

Various groups which have been assigned to Gymnosperms date back to the remote geologic past. Pteridosperms appear first in the lower Carboniferous, Cordaites and Conifers in the Upper Carboniferous and ginkgophytes in the Permian. Cycadales and Bennettitales are the Mesozoic groups.

What were the primitive Gymnosperms like? The Devonian is the age where we should look for primitive gymnosperms or the groups of forms from which gymnosperms must have arisen. Special attention is drawn to some of the Devonian genera about which we have known better in recent years. They are *Aneurophyton, Eospermatopteris, Protopitys, Pitys, Archaeopteris* and *Callixylon* etc. They are characterized by secondary growth and arborescent, or possibly shrubby habit, secondary tracheids with gymnospermous round bordered pits and compound or

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branched leaf; but at the same time all were pteridophytic in reproduction. Are these the forms which were ancestral to gymnosperms? If it were so the existence of such plants of possible psilophytic origin, eliminates the necessity of considering any group of ferns as ancestors of the gymnosperms.

3 A. R. RAO (Lucknow) : *The Podocarpaceae in the Rajmahal Flora of India.*

I will confine my observations to just one group of gymnosperms namely the Coniferales and in that, the Podocarpaceae. The Podocarpaceae are regarded as an essentially Southern family and all the living members of this family are now confined mostly to the Southern hemisphere although a few species of *Podocarpus* cross the equator. The group is represented in a fossil state only from the Mesozoic onwards.

The Jurassic flora of India—particularly the Rajmahal flora is rich in conifer remains some of whose affinities are quite clear. The fololwing are known to be definitely Podocarpaceous. Woods : *Mesembrioxylon* Spp. *shoots* : *Elatocladus jabalpurensis* Fst. *Elatocladus plana* (Est.) *Elatocladus conferta* (O & M) Halle, *Retinosporites indica* (O & M) Reproductive organs : *Strobilites Sewardi* (Sahni) *Stachyotaxus* sp. *Nipaniostrobus Sahni* Rao, *Nipanioruha granthia* Rao, *Podosporites tripakshi* Rao and possibly *Masculostrobus rajmahalansis* Rao, *M. sahni* Mittre, *Pityosporites nipanica* and *Pityosporites* spp. These indicate the existence of a rich Podocarpaceous oelemet in the Indian Mesozoic flora. They further extend the vertical range of the group into the Jurassic age and show that the Podocarpaceae are indeed a southern family. Prof. Florin thinks that the conifer flora had become differentiated into two large phytogeographical dominions from the Permian onwards, and that the Podocarpaceae dominated the Southern conifer vegetation. The genera enumerated above strongly support to some extent Florin's theory. Florin also thinks that *Dacrydium* developed in the upper Mesozoic from some centre in East Australian or Antarctic region. *Nipaniostrobus Sahnii* is most comparable to *Dacrydium*. *Acmopyle* is supposed to have developed from an origin centre in the Indo-Australian region to Antartica and South Africa. *Retinosporites indica* according to Florin is perhaps an *Acmopyle*. *Phyllocladus Saxegothaea, Pherospaera* and *Microcachrys* are also regarded as southern. The last three are not represented in a fossil state. Scattered pollen referred to above as *Podosporites tripakshi* can be compared to the pollen of *Pherosphaera* and *Microcachrys*. From the Jurassic of Australia Florin has described *Zamites* (*Podozamites*) *Barklyi* McCoyi Florin sp. nov., resembling a species of *Podocarpus* and *Elatocladus* sp. comparable to juvenile leaves of *Dacrydium intermedium*. From the Tertiary of Australia *Podocarpus precupressus, Dacrycarpus australiensis, Dacrydium rhomboidium, D. araucarioides, D. cupressinum* and sporomorphs of *Dacrydium florini, Phyllocladus palaeogenicus* are also known. *Microcachrites antarcticus* is also probably *Podocarpaceous*. It thus appears that most of the Podocarpaceous fossils are from the Southern hemisphere. The present day distribution of the living Podocarpaceae is also confined mostly to the southern hemisphere, to only those lands that constituted the 'Gondwana land' at one time. This is rather significant and strongly suggests that this family really evolved in the Southern hemisphere, in Gondwana land.

The living Podocarpaceae show three main types of organization of the strobilus, (a) a compact cone, as in *Dacrydium* (b) a lax strobilus and (c) much reduced single seed-bearing receptacle as in *Podocarpus blumei*. The Rajmahal petrified strobili referred to above show that the compact cone and the lax strobilus were in evidence during the Jurassic period. We do not have enough data yet to definitely state that the reduced *Podocarpus blumei*—like single seeded receptacle was also present in the Indian Jurassic flora, although there are some suggestions to this effect.

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4 T. N. KHOSHOO (Chandigarh) : *Cytological Evolution in Gymnosperms.*

Approximately 42% species of the gymnosperms have been studied cytologically. The investigated species cover about 82% genera, representing all the 13 living families. This leaves roughly 371 species and 13 genera (including the recently discovered Chinese genus *Cathaya*) totally unworked. A perusal of this data indicates that the major cytogenetic processes of evolution in the group are the karyotypic alterations, gene mutations and hybridization. Polyploidy is very low in incidence, being totally absent in Cycadales and Ginkgoales. Clear cut cases of agamospermy are also unknown in the group.

This paper gives a short account of the genetic system of a typical gymnosperm, trends in karyotypic evolution, probable causes for rarity of polyploidy and apomixis in the group, and, lastly, the scope and limitations of the cytological and cytogenetical studies in the understanding of interrelationships within the gymnosperms.

5. D. C. BHARADWAJ (Lucknow) : *Pollengrains of Ephedra and Welwitschia and their Probable Fossil Relatives.*

The pollengrains of *Ephedra foliata* Boiss., are pointedly oval with a number of contiguous ridges extending longitudinally from the two ends. The vertex of the ridges is well defined and wavy whereas the groove or colpus in between the ridges is straight but faintly apparent. A t.s. of the nearly mature grains is ± circular with 14-18 teeth-like projections (the ridges) each with an acute apex and a broad base immediately below which is a thin glistening layer of exine followed by a darker lining layer. In fully matured grains the ridges develop a cavity inside, due to the separation of ektexine along the glistening layer. In immature grains the ridges are rounded without a defined crest and the grooves at the base of the furrow are prominent. In general, the pollen morphology for most of the other species of *Ephedra* agrees to that of *E. foliata.*

In early history, dispersed, fossil pollengrains comparable to those of *Ephedra* are shown to occur in strata extending to Permian.

The pollengrains of *Welwitschia mirabilis* Hook., are pointedly oval with a single deeply concave invagination running longitudinally. In a t.s. through the middle they appear horse-shoe shaped. The surface of the exine in mature grains bears a number of longitudinally running, low and rounded ridges with narrow, sharply defined grooves in between them. In immature grains, minute, closely spaced grooves and ridges running transversely over the exine and the slight separation of ektexine from intexine at the pointed ends, not traceable in mature grains have been observed.

In the geological past, monocolpate fossil pollengrains organisationally comparable to such of *Welwitschia* have been known from Bennettitales, Cycadales and Pentoxyleae of the Mesozoic and the modern *Ginkgo.* In addition to these a number of dispersed, fossil pollengrain genera are reported from strata extending to Permian which show fairly close similarity with the pollengrains of *Welwitschia.*

It has been concluded that morphographically the pollen grains of *Ephedra* and *Welwitschia* substantially differ from each other and that the pollen morphology of *Welwitschia* brings Welwitschiales still closer to Bennettitales with which it is already known to correspond in respect of stomatal apparatus, ovule and seed structures as well as floral morphology.

6. VISHNU MITTRE (Lucknow) : *The Ice Ages and the Evolutionary History of the Indian Gymnosperms.*

The glacial epochs are instrumental in numerous ways in creating circumstances directly affecting the evolution of new taxa and in changing the pattern

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of vegetation. The repeated manifestations of the climatic changes, the creation of land bridges and the land barriers in the past have governed the immigration of the plant species and the shifts in the vegetational belts both latitudinally and altitudinally. The diastrophic events have further helped processing the evolutionary trends.

In the background of the successive climatic and physiographic changes during the Pre-Pleistocene and Pleistocene Ice ages, an outline of the evolutionary history of the Indian Gymnosperms is presented.

The long period of time between the Permocarboniferous glaciation and the onset of the Pleistocene Ice age has witnessed the origin and the immigration of gymnosperms and their luxuriant growth during the period of increasing warmth, and their gradual diminution and virtual extinction during the period of climatic optimum (Eocene). The progressive deterioration of climate during the late Tertiary period (Miocene and Pliocene) helped the gradual immigration of the modern conifers which established themselves during the Pleistocene Ice age. Whereas the climate had been largely responsible for their immigration and spread until towards the beginning of the Postglacial period, thereafter the coniferous vegetation has also been partly affected by the anthropogenous influence by clearance of forests and by plantation of both the indigenous and the exotic spp.

The successive changes of climate and physiography during the Pleistocene period resulted in the disjunct distribution of the once widely and continuously spread plant species and since that time the species isolated have been struggling hard against the new and the changing environments. It is amongst these that the new evolutionary trends may be recognised manifested in the physiological and ecological races—the ecospecies—which constitute the potentials of the future gymnosperms of India.

7. C. G. K. RAMANUJAM (Hyderabad) : *Xylotomy of the Gymnosperms.*

The present paper deals with the structural specialization of the xylotomy (primary and secondary wood) of the four large groups of gymnosperms viz., pteridospermophyta, cycadophyta, coniferophyta and chlamydespermophyta.

Xylotomical features cannot be taken by themselves, as infallible criteria in the identification, classification and phylogeny of the diverse orders of the gymnosperms.

Xylotomically the pteridosperms show little or no relationship with the cordaitales, their palaeozoic contemporaries. The early cessation of the activity of the cambium as evidenced by the pteridosperm stems probably represents a primaeval state of affairs among the gymnosperms. The xylotomy of the pteridospermophyta is very much unspecialized; the tracheids are very long and broad and show copious reticulate-bordered pitting which, palingenetically represents the primitive type of pitting for this group. The xylem rays are very high, broad and heterogeneous, with the ray cells primitively thin-walled, smooth and unpitted.

The wood of cycadophyta is, as a rule, manoxylic with a broad zone of transition between the protoxylem and the secondary tracheids. Radial pitting is largely scalariform in cycadeoidales and circular bordered in cycadales. Xylem rays are homogeneous, narrow or moderately broad, with all the walls thin, smooth and unpitted.

Xylotomically the cordaitales, ginkgoales and coniferales constitute a well-knit and closely interrelated group. The wood of the coniferophyta is characteristically pycnoxylic. With the exception of cordaitales the primary wood of the rest, is highly specialized. No scalariform pitting is found in the wood. Radial pitting is broadly of two types viz., cordaitè-araucarian and abietinean; the former is geologically the older of the two. The evolutionary specialization of the xylem

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parenchyma, ray sand the resin ducts, has been broadly discussed. There seems to be no definite correlation between the xylem parenchyma and the appearance of seasonal growth.

Xylotomy of the gnetales is of a very advanced type among the gymnosperms. Xylotomically the genera *Ephedra, Gnetum* and *Welwitschia* are more closely interrelated than any one of them is related to any other gymnosperm.

Fossils of the upper Cretaceous and lower Tertiary periods indicate that there has been no appreciable change in the structural specialization of the xylotomy of gymnosperms during the last 60—80 million years.

III. PARASITISM AND SYMBIOSIS

Chairman : PROF. J. VENKATESWARLU, Waltair.

1. T. S. SADASIVAN (Madras) : *Opening remarks—General.*

Parasitism in a broad sense is ascribable to any agent capable of interfering with the life processes of a host, be it of microbial origin, or one of the angiosperms themselves. Generally, the more vigorous and destructive a parasite, the less its chances of survival, and conversely, the more tolerant the host to a parasite, the more chronic the disease and greater are the chances of survival of the parasite. The story of breeding wheat for resistance to *Puccinia graminis* in the U.S.A. clearly indicates what a checkered history it has had with every new race and biotype of the rust fungus that nature put up to match the ingenuity of the breeding programme for evolving resistant wheat varieties. The control of parasitism in fungi is complex as there is no proved defence reaction in plant tissue akin to antibody formation in animals. Nevertheless, the recent report of the formation of what appears to be an antibody in orchid bulbs, in the form of a substance called orchinol, consequent on infection of tissues, is a major break through in this fascinating field of host-parasite relationship *in vivo*.

The barrier to infection by plants resistant to fungal obligate parasites with external mycelia seems to be susceptibility of host cell cytoplasm to fungal metabolites and in extreme cases of obligate parasitism like in *Plasmodiophora brassicae* this association is within the host cytoplasm itself. Types of barriers in plants that affect parasitism are to be mentioned and discussed.

Symbiosis, on the other hand, is as complex as parasitism and defies being explained in any simple manner. While lichens and nodule bacteria represent ideal examples typifying commensalism, in recent years, the role of algae in such commensal association with the angiospermous plant has come into limelight. They are now known to liberate extracellular metabolic products having ecological importance in soils. Their capacity to fix atmospheric nitrogen seems beyond doubt and, therefore, their association in roots of *Cycas* and orchids may throw new light on the phenomenon of symbiosis.

2. C. V. SUBRAMANIAN (Jodhpur) : *General aspects of symbiosis.*

Symbiotic associations between microorganisms and other microorganisms or plants or animals are as varied as they are widespread. These include associations of algae with fungi to form lichens, of algae (*Zoochlorella, Zooxanthella*) with freshwater and marine animals; of fungi with plant roots to form mycorrhiza, of yeasts and yeast-like fungi in the rumen of sheep and other animals and also associated with wood-feeding and plant-sap-sucking insects, of *Septobasidium* spp. with scale insects, of fungi and ambrosia bettles; of bacteria (*Rhizobium* spp.) with roots of legumes to form nodules, and of bacteria forming an essential

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intestinal microflora in many insects and animals. A brief survey of our present knowledge of the physiology of these relationships is presented, aimed at an elucidation of the nature of the relationship in each case, as far as is known. From what we know of these, it appears that the ability of two ((in a few cases more) partners to live together in stable balance without destroying the other or being destroyed is the essence of symbiosis. There is almost always mutual benefit for the partners, but the extent to which each partner benefits *vis-a-vis* the other varies. Elucidation of symbiotic relationships in the past has largely been guided by studies of the behaviour of the symbionts separately (*in vitro* if symbiont is a microorganism) with a view to ascertain their inherent individual nutritional and other requirements. These studies have often revealed heterotrophy for one or both partners. Speculations on the origin of heterotrophy and indeed of the symbiotic association itself have been made in the past and are interesting, but speculations will have to be built on critical and intensive study of the symbionts not only separately as has been done in the past but also in association with each other as they are seen in nature.

3. Miss L. SARASWATHI-DEVI (Madras) : *General aspects of parasitism.*

Parasitism is, by definition, living at another's expense and, hence, an *attack* by one organism on another, and is essentially dualistic and antagonistic. In other words, a parasitic organism meets its primary requirements of nutrition by encroaching on another living organism. This association being thus essentially a nutritive one, it is seldom that the attacked host is left uninjured, and this has led to the rather indiscriminate usage of the terms "parasitism" and "pathogenicity". The two are not synonyms and certainly pathogenicity is not the ultimate aim of a parasite. Practically, however, it is almost impossible, at least as far as plant parasites are concerned, to draw line between parasitism and pathogenicity. By far the majority of instances involve a microorganism parasitizing a more highly evolved organism.

Parasites may be necrotrophic (destructive) or biotrophic (balanced). The former are usually strong producers of exocellular metabolites such as enzymes and toxins which destroy the host tissue, whereas the biotrophic parasites, of necessity, do as little damage to the host as possible so as not to jeopardize their own development, at least till the fruiting stage. The smuts are excellent examples of such balanced parasites.

From the primitive type of necrotrophic parasite we have different gradations all the way up to the obligate and highly specialized balanced parasitism, of which the conventional symbiosis, such as that of mycorrhiza, is but the ideal condition. The degree of host damage and of specialization and specificity in parasitism is governed by many factors including the innate nature of the parasite, its nutritional requiremens, the nature and type of resistance it has to encounter in the host.

Parasitism, *i.e.*, the ability to attack and grow in living tissue, is definitely a positive capacity, in the evolution of which, however, the organism had to forego other properties, and this leads one to the philosophical conclusion that nothing is gained without giving, and that specialization involves a good amount of sacrifice.

4. B. TIAGI (Jodhpur) : *Abnormal growth and parasitism.*

Parasitism by microorganisms leads to disease in plants. Besides the usual symptoms, the host tissues may show abnormal growth forming galls, tumours and witches' brooms. There may also be associated some secondary effects on the host resulting in the transformation of floral organs into curious structures.

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Agencies causing abnormal growths in plants are : insects, nematodes, fungi, bacteria, viruses and non-parasitic factors.

An attempt has been made to review the literature on the subject and the work which is being done in this laboratory on the following : *Physoderma, Synchytrium, Protomyces, Protomycopsis, Uromyces,* Rusts, *Albugo, Taphrina,* and *Sorodiscus.*

Galls are classified variously; depending upon the agency making the gall, pattern of development, morphology and histology.

Braun recognises two types of abnormal growths.. Self-limiting having a definite pattern of development and non-self-limiting tumours possessing transplantable cells, proliferating randomly. Tumour cells acquire autonomy, the nature of which may lead to an understanding of similar cancerous growths in men and animals. Crown galls caused by *Agrobacterium* are of this nature. Self-limiting galls include insect, virus and fungal galls, bacterial root nodules and nematode root knots.

Butler and Jones classify abnormal growths as Histoid and Organoid. The former are due to a local stimulant action. Organoid galls result from systemic infection, inducing changes in habit and symmetry.

Gaumann recognises four types of abnormal growths : galls, tumours, witches' brooms and activation of rudimentary sexual organs. The morphogenic stimulus affects a cell or parts of tissues in forming galls and tumours and the whole buds in witches' brooms.

Following are critically reviewed : (1) Fungi—*Plamodiophora, Synchytrium, Physoderma, Albugo, Peronospora, Peridermium, Nectria, Sphaeropsis, Taphrina, Exobasidium, Haplophragmiopsis, Uromyces, Uromycladium, Gymnosporangium, Ustilago, Tilletia, Urocystis, Melanopsichium, Melanotaenium,* and *Pericladium.* (2) *Agrobacterium tumefaciens* and Virus malformations.

Profound secondary effects are produced by the following : *Albugo, Peronospora, Sclerospora, Taphrina,* Rusts and smuts.

5. H. S. NARAYANA (Jodhpur) : *Morphology and anatomy of nodules.*

The nitrogen fixing bacterial nodules are present on the roots of legumes and certain non-legumes besides a report on stem of a legume.

The two types of nodules (effective and ineffective) on the basis of nitrogen fixation are distinguishable externally by the size and colour and internally by the meagre or total absence of bacteriod area and high percentage of disintegrating tissue. In contrast to the general conception, the effective nodules may be present even on the tertiary and quarternary roots as observed by the author in *Dolichos biflorus, Cymopsis tetragonoloba, Vigna caljang,* besides on the primary and secondary roots. They are either endogenous or exogenous in origin.

The effective nodule consists of the central bacteriod region, outer nodule cortex supplied by the vascular strands and distal miristematic zone. There may be a general endodermis outside the nodule cortex or individual endodermis around each vascular bundle. The presence or absence of meristematic zone cannot be correlated with endogenous or exogenous origin of nodule : The vascular bundles that supply the nodule exhibit varaition in number and orientation in nodules of different hosts, nodules of the same host and even in the same nodule at different heights. The variation in the percentage of infected to the uninfected cells is also met with.

The mode of infection is predominantly through the root hairs, although infection through ruptured cortical cells in the vicinity of lateral root and the epidermis is known.

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The nodules in the perennials are long-lived and in some bear rootlets developed within the endodermis of the vascular strands. The author will present his own observations and discuss the aforementioned points.

6. N. RAJAGOPALAN (Madras) : *Physiology of nodule function.*

The basis of effectiveness in root nodule symbiosis seems to depend on a biochemical compatibility between the host plant and *Rhizobia.* A possibly fundamental role may be played by chlorophyall synthesis in the leaves in apportioning levels of adaptation such as effectiveness, ineffectiveness and parasitism, since nodules are not formed in root cultures. One at least, of the biochemical host properties which confer effectivity, is the synthesis of haemoglobin in "effective" root nodules. This haemoprotein is formed as a result of a specific interaction between a compatible bacterial strain and the proliferating host tissue. Pertinence here attaches to a positive correlation between hamoglobin content and the intensity of nitrogen fixation.

Factors governing the formation and function of this metalloporphyrin protein in the root nodules remain at present largely obscure, although glycine has been shown to be a specific precursor for its formation. Interest centres on this fact since glycine is also a specific precursor for chlorophyll synthesis. Construed in this light, the formation of haemoglobin and a control of its quantitative levels in nodules through levels of illumination of the host plant are suggestive of foliar influence. Such influence in a hypothetical sense may depend on the synthesis of porphyrin precursors or amino acids in leaves.

Thus, the protein metabolism of nodules may have to be integrated with the metabolic induction of specific substrates in leaves. The significance of these factors in the light of work carried out in this laboratory will be discussed.

7. R. S. BADAMI (Madras) : *Viruses and parasitism.*

Virus host physiology in terms of disturbances in the protein metabolism of the host have taken several avenues of expression. And obligate parasitism which is an intrinsic property of viruses ranges from strict pathogenicity to a balanced commensalism with reference to the host plant. Relatedly, work on the morphological structure of virus particles has led to a measure of agreement on their properties of infectivity and serological specificity.

Emphasis however is placed on the physiological condition of the host plant since it conditions to a large extent the ability of a virus to infect, multiply and cause symptoms. This naturally leads on to the subject of transmission of virus diseases from one host to another. And apart from normal modes of transmission through the soil and mechanical means, viruses are also carried through aphids, leaf-hoppers and also multiply in them. The specificity of virus-vector relationships have become so complex that nothing short of inroads into insect physiology can explain them. Another degree of relation is the pathogenic nature of viruses to transmitting insects as well as to susceptible plants. Specific instances are known of Polyhedral and other virus diseases proving lethal to insect pests (pine saw-fly). Application of this in biological control of injurious insects is yet in its infancy.

These aspects with regard to the role of diverse factors and the physiological state of the host plant in relation to Tobacco mosaic virus and Dolichos enation mosaic virus and also biological partnership of host plant in relation to Cucumber mosaic virus and Potato viruses will be presented.

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8. N. S. SUBBA RAO (Madras) : *"Ectotrophic fungal associations with roots".*

The surface of roots with the attendant microflora is often referred to as the rhizoplane. It constitutes the innermost stratum of the rhizosphere, the zone of interaction between plant roots and soil microorganisms. A specialized case of fungal association in the rhizoplane has resulted in the origin of ectotrophic mycorrhiza where the bulk of the mycelium forms an external mantle around the roots with the intercellular Hartig's net acting as the liasion-tissue between the two symbionts. The ectendotrophic mycorrhiza represent a case of root-fungus association where the hyphae of the intercellular Hartig's net occasionally penetrate the cell-lumina of the higher symbiont. Intracellular penetration of the fungal hyphae into the luminae of the root cells followed by the digestion of the hyphae is a rule in endotrophic mycorrhiza. These transitional series of associations may be viewed as a probable line of evolution from the rhizoplane habit. Experimental evidence relating to the two-way biological relationship between the symbionts such as the part played by the fungus in salt absorption, the liberation of vitamins by the roots and their utilization by the fungus together with the role of the fungus in the morphogenesis of the root system of some trees will be surveyed. While much attention has been paid to the associative and antagonistic effects of microorganisms of the root region, relatively little is known concerning the part played by them in the well-being of the plant; an attempt has been made in this direction by the author and the results obtained will be discussed.

Section of Medical and Veterinary Sciences

Chairman : DR. J. C. BANERJEA, Calcutta.

1. J. C. BANERJEA and J. C. BAL : *Studies on Hepatic Cirrhosis.*

Cirrhosis of liver in our country was so long regarded as mainly due to nutritional deficiency. Recently Gillman and Gillman have shown that cirrhosis of liver does not follow the nutritional deficiency in kwashiorkor. With a view to ascertain the aetiology of cirrhosis of liver in our country, 36 cases showing hepatosplenomegaly with or without jaundice and ascites were investigated clinically and histological examination of liver biopsy specimen was made in 29 of them. Relevant biochemical examinations and radiological study by means of splenic venography and barium swallow of the oesophagus were made.

Results of investigations revealed that a previous history of viral hepatitis could be obtained in 36% of cases. A histological diagnosis of post hepatitis cirrhosis of liver could be obtained in 21 cases, which could be correlated with the clinical, biochemical and radiological findings. 4 cases where liver biopsy was not corroborative were presumed to be of viral aetiology from clinical and biochemical evidences. Three cases were in all probability cases of portal cirrhosis. Five cases were likely to be cases of primary portal hypertension syndrome. One case showed cardiac cirrhosis and remaining 2 cases did not show evidences of cirrhosis.

Thus 34 cases of the series presented cirrhotic changes in the liver, out of which 25 cases (73·5%) were cirrhosis of viral origin. The incidence of portal cirrhosis was definitely insignificant in this series.

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2. G. S. MAHAPATRA (Cuttack) : *Hepatic cirrhosis and ascites.*

A total of 88 cases of Ascites has been studied from various angles. In all these cases detailed history and clinical findings were obtained with special reference to social status, dietetic habits, addiction habits, history of attack of Jaundice and history of Gastro-Intestinal bleeding episodes. The ascitic patients were divided into four groups :—

Degree I Ascites—Marked abdominal protuberance. Shifting dullness +. No fluid thrill. Abdomen skin loose.

Degree II Ascites—Moderate protuberance of abdomen. Shifting dullness ++, no fluid thrill. Abdominal skin slightly tense. No prominent superficial veins.

Degree III Ascites—Marked abdominal protuberance. Shifting dullness ++, fluid thrill ++. Abdominal skin tense slightly prominent superficial veins. Eversion of umbilicus.

Degree IV Ascites—Very marked protuberance. Shifting dullness +++, fluid thrill +++. Superficial veins prominent. Marked eversion of umbilicus.

In all these cases the following investigations were carried out :

1. Liver function tests.
2. Liver Biopsy.
3. Radiological Examination.
4. Ascitic fluid examination.

Of the 88 cases studied, only 48 cases were diagnosed clinically as cirrhosis of liver. Liver Biopsy was attempted in 31 patients of this group ,of which three were unsuccessful even on second attempt probably because the liver was too shrunken and hard. In rest of the 28 cases biopsy revealed normal liver pattern in six cases, diffuse hepatic fibrosis in 15 cases, post necrotic cirrhosis in three cases and early fibrosis with marked changes in four cases.

The grading of hepatic fibrosis was carried out according to histological criteria described by Mangalik et al. All cases with normal liver pattern and most cases with early hepatic fibrosis had lesser degree of Ascites (I & II degree). Among those with diffuse hepatic fibrosis there was seen a fairly direct relationship between the amount of fibrosis in the liver and the degree of Ascites. The greater the hepatic fibrosis the greater was the amount of fluid in the peritoneal cavity.

3. J. C. BANERJEA : *Evaluation of modern oral diuretics.*

Some of the modern oral diuretics such as Benzthiazide (Fovane); Bendrofluazide (Aprinox, Neonaclex), Hydroflumethiazide (Naclex), Hydrochlorothiazide (Esidrex) were tried by turn in four groups of oedematous patient viz., Cardiac, Cirrhotic, Nephrotic and Nutritional for a period of four days each, interposed with a period of four days during which no diuretic was used. Before starting a diuretic, the patient was kept at bed rest on a standardised diet containing about 3 G of Na -(Sodium). Fluid intake was not restricted, and average of the total urine output in 24 hours for four days was estimated. The diuretic response was considered good if the average output during the 4 days' period of diuretic therapy was increased by 100% or more above the average basal output; fair, if, increase of 50% to below 100% and poor if response is below 50%. Serum sodium and Potassium estimations were made in 8 cases before and the end of the diuretic therapy. No significant alterations were observed.

Irrespective of the type of oedema, diuretic response was best with Benzthiazide and next in order of efficacy were Bendrofluazide, Hydroflumethiazide, Hydrochlorothiazide.

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In cirrotic oedema Benzthiazide and Hydroflumethiazide both were of equal efficacy with a good response. Next in order of merit were Hydrochlorothiazide and Bendrofluazide of equal efficacy.

In Cardiac oedema Hydroflumethiazide appeared to give the best diuretic response; next in order of efficacy were Benzthiazide, Bendrofluazide and Hydrochlorothiazide.

In Nephrotic oedema Benzthiazide appeared to give the best diuretic response. Hydrochlorothiazide, Bendrofluazide both appeared to give the next best diuretic response. Hydrochlorothiazide was next in order of efficacy.

Benzthiazide and Bendrofluazide both appeared to give same diuretic response in Nutritional group of oedema cases. Next in order of efficacy were Hydrochlorothiazide and Hydroflumethiazide.

4. J. B. CHATTERJEA (Calcutta) : *Chronic haemolytic anaemias—Aetiopathogenetic aspects.*

In chronic haemolytic anaemias, erythrocytic life span is always shortened so that more red cells are destroyed than can be formed by the compensatory bone marrow activity. The excessive haemolysis beyond physiological limits may be predisposed by an intrinsic intra-erythrocytic defect or is brought about by extra-erythrocytic haemolytic factors. The intra-erythrocytic defects represent hereditary disorders and include the following :

(a) *Haemoglobinopathic syndromes* viz., Homozygous thalassaemia; Homozygous states for various abnormal haemoglobins (S.C.D.E.); Double heterozygote states (Hb. E-thalassaemia, Hb. S-thalassaemia) and other related disorders. The main anomaly is in tht sequence of aminoacids that form the polypeptide chains.

(b) *Haemolytic reactions* following exposure to certain agents, viz., primaquin and fava beans. These affect only those subjects who exhibit a deficiency of erythrocytic enzyme, glucose-6-phosphate dehydrogenase.

(c) *Hereditary spherocytosis* and related disorders. The extraerythrocytic haemolytic factors are exemplified by infections, immunologic disturbance due to isoimmunisation or auto-immunisation and hypersplenism.

Haemoglobinopathic disorders constitute a significant problem in India. In West Bengal 7·6% of general population has been shown to possess haemoglobinopathic trait of some form or other. Approximately 5% of Indian population shows deficiency of erythrocyte glucose-6-phosphate dehydrogenase activity of red cells. In India incidence of hereditary spherocytosis is much lower than that of haemoglobinopathy or enzyme deficiency.

5. RATHINDRA NATH RAY (Calcutta) : *Diagnosis of Chronic haemolytic anaemias.*

Chronic haemolytic anaemias may be due to intracorpuscular or extracorpuscular defects. Disorders like haemoglobinopathy, hereditary spherocytosis and auto-immune acquired haemolytic anaemia will be discussed.

The diagnosis depends on thorough clinical and laboratory investigations. In the clinical study, evaluation of age, sex, duration of illness, degree of anaemia and jaundice, facies, enlargement of spleen and liver should be properly done to get some idea about the type of disorder.

In the laboratory investigations, various haematological data both in the peripheral blood and in the bone marrow provide useful informations. The presence of osmotically fragile red cells in hypotonic saline solution along with positive Coombs test indicates auto-immune haemolytic anaemia, whereas in hereditary spherocytosis

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though the red cells are fragile but the Coombs test is negative. Electrophoresis of haemoglobin is a useful procedure for proper characterisation of haemoglobinopathic syndrome. Radiological changes in bones in congenital haemolytic anaemias and changes in stool and urine due to hyperhaemolysis give corroborative evidences in favour of chronic haemolytic anaemia.

Last but not the least, thorough clinical and haematological investigations of the family members including the parents is important to confirm the diagnosis of congenital haemolytic anaemias.

6. SHARAD KUMAR : *Mechanism of haemolytic anaemia.*

The administration of haemolytic sera to experimental animals for the production of a condition analogous to acquired haemolytic anaemia in humans is a relatively recent procedure. Although reference to such work dates back to Hayem (1898), the first significant observations on the role of haemolysins as the cause of clinical and experimental haemolytic anaemia were made by Dameshek and Schwartz (1938). Since then immune sera against the various formed elements of blood have been extensively employed, not only in the study of the mechanism of haemolytic anaemias Wasastjerna, 1948; Young et al, 1949; Kumar, 1956), but also in the study of purpuras (Bedson, 1921; Witts, 1955) and agranulocytosis (Moeschlin, 1954) experimentally. The present study was undertaken to produce haemolytic anaemia experimentally with a view to investigate the mechanism of its development and to determine the role of spleen in its genesis.

It was observed that the resulting anaemia was acute or chronic depending upon whether the route of administration was intra-cardiac, intraperitoneal or intramuscular. Chronic anaemia developed only in 3 out of 10 guineapigs treated intramuscularly. The development of anaemia took place in three phases. The first phase was concerned with the formation of spherocytes and characterized by progressive decrease in the mean corpuscular diameter, by an increase in mean corpuscular thickness and parallel increase in the osmotic fragility of red cells. This was followed by the second phase in which progressive anaemia developed. The third phase was characterized by marked regenerative activity of the bone marrow. Removal of spleen appeared to protect the animal against the influence of the antiserum as judged by the development and recovery from anaemia, the lethal effect of the antiserum and the formation of spherocytes.

I. STUDIES ON HEPATIC CIRRHOSIS DISCUSSION

The Chairman in introducing the subject drew attention of the audience to its importance and the complicated nature of its aetiology. He requested the members to present their views based on personal experiences.

Dr. G. S. Mahapatra (Cuttack)—From a study of 88 cases of ascites he observed that 48 cases were due to cirrhosis of the liver. He stressed on infective hepatitis as the cause of cirrhosis.

Dr. P. N. Sahu (Cuttack) discussed the role of alcohol, deficiency of the various lipotropic factors such as choline, methionine, etc., and of infective hepatitis in the pathogenesis of hepatic cirrhosis.

Dr. A. M. Tripathy (Professor of Pathology, Medical College, Cuttack) described the invariable occurrence of extensive ulceration of the intestines in cases of hepatic cirrhosis and discussed at length on the role of endocrines in the pathogenesis of cirrhosis.

Dr. P. C. Sen Gupta (Calcutta) spoke on the various environmental factors and thought that the role of malaria and amoebiasis in the causation of cirrhosis should be considered.

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Dr. Sujata Chowdhury (Calcutta) stressed on the importance of malnutrition and chronic enteritis in the causation of cirrhosis and of the gamma globulin as a protective factor.

Dr. Pande spoke on the value of immuno-electrophoresis in the diagnosis of cirrhosis of the liver.

Dr. V. K. Nanda thought that cirrhosis was the result of some blocking of the hepatic tissues. He stressed on the importance of biopsy in the diagnosis of cirrhosis.

Shri H. N. Das (Bhubaneswar) spoke of hepatic cirrhosis occurring in animals due to liver fluke infections.

Shri C. Seetharaman spoke of an infective hepatitis occurring in ducks and pointed out that it may be the probable cause of cirrhosis.

In summary the Chairman emphasised that from his studies in collaboration with his colleague Dr. J. C. Bal it appeared that infective viral hepatitis was the most important cause of hepatic cirrhosis, at least in the State of West Bengal. Portal cirrhosis (Laennecs' type) was rare. Nutritional deficiency played an insignificant role.

II. NEWER ORAL DIURETICS : THEIR ACTIONS AND USES

Chairman : Dr. J. C. Banerjea, Calcutta.

Dr. B. B. Roy (Calcutta) in his introductory remarks spoke on the basic mechanism of urine secretion and how it was influenced by the newer oral diuretics of the thiazide group as compared to the mercurial diuretics. The basic mechanism of the secretion of urine was more related to the role of enzymes on the function of the renal tubulas than of the glomeruli. The diuretic agents modified the enzymatic action. He discussed the drawbacks of these diuretics which caused ionic imbalance. In conclusion he pointed out the value of these newer diuretics of the thiazide group as prophylactic agents against nocturnal cordiae dyspnoea.

Dr. Ojha (Cuttack) dealt with the pharmacological aspects. Besides enzymes, neurochemical and metabolic products were also essential for diuresis. Calcium used intravenously acted as a good diuretic agent.

Dr. B. Tripathi (Cuttack) listed the various newer oral diuretics and enumerated their uses in conditions with or without oedema. From clinical trials (78 observations in 48 patients) with hydrochlorothiazide he concluded that it was most effective as a diuretic agent in hepatic oedema, moderately effective in nutritional and nephritic oedema, and less effective in cardiac and nephrotic oedema. The efficacy was assessed on the basis of decrease in body weight from the pre-treatment level and increase in urine output over the pre-treatment average output. He pointed out that digitalis in cardiac oedema and prednisolone in hepatic oedema augmented the effect of the diuretic agent. In hepatic and cardic cases hydrochlorothiazide was found to be superior to chlorothiazide or to neptal injections. It also potentiated the anti-hypertensive action of pentolinium tarturate (ansolysen) and apresoline.

Dr. G. S. Mahapatra pointed out the toxic effects of diamox such as enteritis, frequent micturition and sudden death.

Dr. J. C. Banerjea, Chairman, high-lighted the points of discussion and confined his remarks to the thiazide group of diuretics only. In his experience hydrochlorothiazide did not prove to be superior to mercurial diuretics in the management of cardiac or hepatic oedema. He advocated the intermittent use of the

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thiazide group of diuretics to avoid hypopotassaemia. Hence the combination of an antihypertensive drug such as reserpine with hydrochlorothiazide for daily use was not desirable. From observations in a limited clinical trial with three oral diuretics, viz. hydrochlorothiazide, hydroflumethiazide and benzthiazide. Dr. Banerjea found that in cardiac oedema all the three diuretics were equally effective provided adequate digitalisation was maintained. Benzthiazide was the most effective diuretic in nutritional and nephrotic oedema, whereas hydroflumethiazide proved superior to the other two diuretic agents in the management of cirrhotic oedema. He stressed, however, on the necessity of further extensive clinical trials for a proper evaluation of the newer oral diuretics.

I. MAXIMISATION OF AGRICULTURAL PRODUCTION

Section of Agricultural Sciences

Chairman : PROF. P. K. SEN, Calcutta.

1. Dr. J. N. Mukherjee (Calcutta) opened the discussion and particularly emphasised the importance of introducing crop rotation in our agricultural practices.

2. DR. B. N. SAHU (Bhubaneswar) : *Maximisation of Agricultural Production.*

The basic objective of India's development is to provide the masses of Indian people the opportunity to lead a good life. This is possible only by increasing production level than at present. So in the scheme of development the first priority has been given to Agriculture. The agricultural production has to be increased to the highest level feasible. A target has been fixed to increase the production of food grains and other agricultural commodities by 32 and 30 per cent respectively by the end of the Third Five Year Plan.

The principal technical programme for increasing agricultural production around which intensive work has to be organised, as laid down in the Third Five Year Plan are (1) irrigation, (2) soil conservation, dry farming and land reclamation, (3) supply of manures and fertilisers, (4) seed multiplication and distribution, (5) better agricultural implements, (6) adoption of improved agricultural practices and (7) plant protection.

Top crop begins with best seed.

Yielding ability of a crop is an inherited character and differs among varieties. Pure seed outyields commercial and non-certified seeds. It eliminates immature, partially filled and shrivelled seeds and thereby ensures higher percentage of germination. Absence of varietal mixture produces more uniform plant height and maturity minimising harvest loss. Absence of weed seeds minimises competition for space, light and nutrition. It is for this the Food and Agricultural Organisation (F.A.O.) of the United Nations has declared the year 1961 to be the World Seeding Year under its campaign for Freedom from Hunger. In Federal Republic of Germany, good seeding, gets the farmer a one hundred fold return. There are model farms which for 60 kilos of seeding rye per hectare, are able to harvest no less than up to 6,000 kilos. Improved seed must be made available to the cultivators in time and close to their door. There should be a seed store to cater to the needs of every 20 villages. Establishment of seed corporation will help production of nucleus seed, maintaining purity and maximum yield. Legislation

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for controlling quality of seeds and regulating their production, marketing and movement should be enacted

Fertiliser is a single factor which can produce high yields and that too in short time. In Western Europe, Japan, Canada and U.S.A. 25 to 50% of total agricultural production can be attributed to regular use of fertilisers. In India, the soil does not get sufficient plant food in return for what it gives in feeding growing crops. Most fertile soils cannot continue to supply all nutrients removed indefinitely. So to meet the nutrient requirement of crops it is essential to provide adequate supply of the nutrients by addition of manures and fertilisers. Recommendations of the Fertiliser Distribution Enquiry Committee regarding use of fertilisers in the form of mixtures with a view to promoting balanced fertilisation, improved arrangements for distribution and reduction in cost of distribution should be taken up. The U.N. Fertiliser Mission have recommended for extensive soil tests to determine the kinds and quantities of fertilisers needed under different conditions. The physico-chemical condition of soil is important. Incomplete response to fertilisers may happen due to poorly developed root system.

No single factor can affect crop production to the same extent as the provision of controlled irrigation in areas where it is needed. Fertiliser application depends upon adequate and timely water supply. In Japan 95% of paddy area is under some type of irrigation. Our Third Five Year Plan provides for an expansion of nine million hectares in the gross irrigated area. Flood control projects can cover an additional two million hectares.

Double cropping or harvesting of two crops e.g. rice is technically possible by means of a fuller development of irrigation potentialities and proper drainage. It balances labour load and is considerably cheaper to provide perennial work. On well drained land cropping patterns can be adopted to get maximum yield during a year from a given piece of land.

Improved agricultural practices will go a long way to maximise production. Small scale subsistence farmers are often too conservative to use improved techniques. Land tenure conditions such as share cropping, poor water control, absence of credit facilities impede or prevent adoption of better practices including use of fertilisers.

Price incentive is another factor. High price to farmers act as an incentive to higher production. Government should have price support policy. Effective guaranteed minimum or official procurement price helps increase in production. Ceylon has deliberately supported Farmer's Price to stimulate production. In Japan the price of crops has been kept high as a general guarantee of farm income.

Package plan—A special feature of India's Third Five Year Plan is package programme. This involves concentration of efforts to raise yields in selected districts of high potential growth. This scheme has to be extended to cover larger area to maximise production.

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3. SRI T. NATARAJAN (Madras) :

In the Third Five Year National Plan 30 to 40 per cent higher targets of Agricultural Production, over the achievements in Second Plan have been set as indicated below :—

1. Food grains	(M. Tons)	100-105	9. Pepper	..	('000 Tons)	30
2. Oilseeds ..	(M. Tons)	9-9·5	10. Cardamom		,,	2·62
3. Sugarcane ..	(M. Tons)	9·00-9·2	11. Lac	..	,,	62
4. Cotton ..	(M. Bales)	7·2	12. Tobacco	..	,,	325
5. Jute ..	(M. Bales)	6·5	13. Tea	..	(M. lbs.)	850
6. Coconut ..	(M. Nuts)	5750	14. Coffee	..	('000 lbs.)	80
7. Arecanut ..	('000 Tons)	100	15. Rubber	..	('000 lbs.)	45
8. Cashewnut	,,	150				

After World War-II, India was trying for self-sufficiency in food grains but with only partial success. However, Agricultural production during the past 10 years (2 plan periods) had increased by about 30 per cent. In the Third Plan it is hoped to attain self sufficiency in food grains and achieve 30% overall increase in all other Agricultural Commodities together in order to meet the needs of the growing industries and for export. Increased Agricultural production is, therefore the key for rapid Economic development of India.

2. The success of maximising Agricultural production, however is dependent on the adoption of Scientific methods, fuller utilisation of manpower in rural areas, through local efforts and reorganising rural economy on the co-operative pattern.

3. For maximising Agricultural production, the following scientific methods and techniques, well known for increasing production, have been introduced in different States in India with varying degrees of success.

(a) *Improved seeds* : Several improved strains of crops have been developed giving on an average of 10 per cent increase in yields, besides possessing better quality, disease resistance or resistance to adverse conditions of cultivation. However what is necessary is a coordinated system of regulated multiplication and distribution of these for saturation of crop areas and periodic renewal of seeds. States should develop a seed certification service also for an effective seed programme.

(b) *Local Manurial resources* : While the requirements of all crops grown can be roughly estimated at about 6 million tons of Nitrogen, the total local (Organic) manurial resources available may be about one million tons, while the potential in the form of F.Y.M., Compost, Green Manures etc. may be upto 10 to 12 million tons. The development of local manurial resources even to the extent of doubling, is a slow process and may have to be planned over a longer period—20 years or more. This requires the local cooperation and effort and rightly Government have brought in the village Panchayats for this purpose in several States.

(c) *Fertilisers* : For immediate increase of crop yields fertilisers are very necessary. By local production and imports, the required quantities have to be made available urgently. Agriculturists have now become fertilizer conscious in several States in India. Yield increases from 20 to 40 per cent are recorded. There is also no risk from the continued use of fertilisers, especially if balanced fertilisation is practised.

The use of fertilisers indirectly increases the organic matter resources in the soil (roots, stubble) and for composting (straws) thus leading to a harmonic utilisation of manures and fertilisers.

(d) *Improved implements* : It is necessary to rapidly develop on a large scale, useful tillage implements for better tillage for better crop production and for

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labour saving, in all Agricultural operations. Bullock drawn implements are needed. Existing facilities are very meagre compared to requirements.

(e) *Plant Protection* : Development of plant protection measures—prophylactic and curative—is necessary to prevent loss of Agricultural produce as over 20-25 per cent of crop areas is usually subject to pests and/or diseases. The required pesticides and equipment have to be imported and indigenous development also planned rapidly.

(f) *Soil and water conservation* : In areas where Agriculture is mainly dependent on rainfall of the area, soil and water conservation measures are of prime importance and take precedence over other technological improvements. Without these, the improvements advocated would not be fully utilised nor be efficient. Besides increasing soil fertility and crop production, these measures improve underground water resources. Efforts should be made to carry out these measures through local people; the Government providing technical guidance, Education and Finance for the changes needed.

(g) *Improved Agronomic practices* : These include composite agronomic practices a "Japanese method of paddy culture," Bombay dry farming system etc. These have regional application, require considerable modification even within small areas, and greater education through Demonstrations. These have not made much progress due to various limitations, in different States.

4. The usefulness and rapid utilisation of Agricultural techniques for increased production, depend upon suitable development of (a) organisations and also (b) institutional reforms :

(a) *Organisations* : In several States, the provision for research and training of technical personnel is inadequate for the task that lies ahead. It is necessary to train more persons for research and extension. Extension service should be expanded greatly and integrated with research and teaching; the regulatory and supply functions being kept separate as far as practicable.

(b) *Institutional reforms* : Supervised credit should be made available to the large body of small farmers and this may be channelled through co-operatives.

For Agricultural supplies, in adequate quantity and in proper time, service co-operatives, have to be developed besides private industries to discharge the functions effectively.

It is also necessary to develop market services—co-operative and regulated—to reach the villages, so that, the producer receives due prices for his produce.

5. *Incentives for Agricultural production* : Fixation of minimum prices for all important crops and announcing them well in advance of crop seasons, will induce investment for increased production.

Similarly in respect of land tenures, cultivators-owners and tenants—should be assured of conditions which will favour investment for higher production.

6. The problem of increased Agricultural production does not consist merely in the advocacy of improved Agricultural techniques but it embraces a variety of human and social aspects as well. It is in this context that the Community Development Programme has an important role to play. Of course, the Community Development Organisation should be so reorganised as to be effective in supplies and services to village Panchayats and Co-operatives, to maximise Agricultural production.

Besides exchanging views and experiences on the various Agricultural techniques adopted in several States, the Agricultural Scientists assembled, may express and exchange views on the other aspects—organisational and institutional—that influence fuller utilisation of the techniques.

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4. SHRI R. GHOSH (Calcutta) :

Population pressure in the State of West Bengal is high and scope for bringing further land under plough is limited. The question of productivity per unit area assumes very great significance in such areas. West Bengal in this respect presents a rather distressing picture of low yields of crops and major area being only single cropped with aman paddy.

Climate, soil, nature of crops and their varieties, irrigation, drainage, manurial, cultural and others are all factors that determine the limits to which crop yields can be increased. In West Bengal and in the major cultivated area in north-east India, maximisation of crop yields will largely consist of effecting yield increases in aman paddy only. Work in India appears to indicate certain limitations of yield increases with the existing varieties. The limit is attained at fairly low levels of fertilizer application even when the percentage of actual utilization by the crop of applied nutrients, is low.

Aman paddy with its seasonal peculiarities offers very little scope for introduction of kharif or rabi crops in a cropping programme. Particularly where aman yields are low, the production can be increased substantially through a substituted and more intensified and diversified cropping pattern. Introduction of crops like aus, maize, jute, oilseeds, pulses, sugarcane, wheat, potato, forages and legumes, green manure crops etc. in a suitable rotation require particular attention in this respect.

Irrigation or assured water in the above respect offer outstanding opportunity for locating suitable crops in a cropping programme on scientific lines that will result in maximisation of production. This is of vital importance for proper land use; maintenance of soil fertility; effective utilisation of labour, capital, implements and farm power; crop insurance; year round employment and better farm returns.

Great stress is being laid on irrigation (tube-well, river pumping, river valley projects etc.) in West Bengal which will open up effective means of increasing the production which very largely has to be through a change in crop pattern with more stress on increased cropping intensity.

5. DR. M. V. MACHANI (Cuttack) :

In conclusion it may be stated that the problem of low productivity of land and instability in food supplies has to be tackled immediately and the knowledge already available at our disposal has to be utilized for increasing the food production. It is true that ours is a large country with wide variation in climatic and soil conditions due to which it is difficult to generalise the recommendations for improvement of crop yields. Hence research has to be intensified in all directions viz. evolution of new varieties, improved methods of cultivation, cheaper and more efficient use of manuring and newer and effective insecticides and fungicides in different soil climatic and environmetal conditions. But various ways for increasing the rice production indicated above can be put into practice with certain modifications in the light of actual observations to suit the local conditions. These methods of cultivation have been advocated by the Agricultural Departments but these have not been adopted on any large scale particularly in case of food crops. This is mostly due to the low-purchasing power and poor economic condition of the grower of the food crops due to which he is not in a position to invest any capital for the purchase of fertilizers, improved seeds etc. Moreover in India farming is not carried out on commercial principles but is only a way of life and as such the cultivator has neither the will nor the means to invest any capital for improvement of land.

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The other bottleneck in improving the crop yield is, however, the wide gap between research and extension and the failure to put into practice on a sufficiently large scale, even simple results, which have proved beneficial. Attempts to change the present position should be directed along the reorganising and reorienting the extension work, creating an army of volunteer propagandists from the villages, arranging for a more intensive multiplication and storage and improved seeds and other supplies to the cultivators in the villages and making them available on easy credit basis.

Therefore, for implementation of any agricultural improvement programme the participation of the cultivator has to be secured by offering him some economic incentive by way of assuring him the minimum price for his produce. Besides establishment of village service co-operatives for timely supply of seeds, fertilizers and other requirements would go a long way in improvement of the standard of cultivation.

6. SHRI DAMODAR MISRA (Bhubaneswar) :

This problem of maximisation of Agricultural production has been receiving the attention of scientists, administrators and politicians since the last 100 years. Most of the suggestions made in this house have been known to us at least 15 to 20 years ago. But in spite of this knowledge, the cultivator has not accepted or adopted the findings of science. The central minister has, therefore, stated that the scientists have failed to bring any impact on the Agricultural production and National Development. One of our previous presidents has remarked that we have neglected to study the cultivator and his problems.

It is accordingly suggested that apart from research work for increasing production which should continue, studies should be initiated to find out the problems which preclude large scale adaptation of the research results with a view to stimulate the farmer for accepting the research findings for increasing production.

7. DR. K. P. SENGUPTA (Kalyani) :

One of the ways to maximise agricultural production is to take more than one crop in a year from the land which is at present producing only one crop. It has been found from actual experiments that under the climatic condition of West Bengal it is possible to raise three crops from the same land in a year with the help of perennial irrigation provided by deep tube wells. It is possible to introduce a variety of crops in this triple cropping programme including green manure crops and fodder crops. A green manure crop is essential at least once every two years if such intensive cultivation is done in order to maintain the productivity of soil. A leguminous fodder crop as one of the three crops will not only provide more nutrition to animals but also enrich the soil. It is thus possible to introduce mixed farming in perennially irrigated areas which will increase the production of food and feed and the green manure crop and cowdung saved will go to increase the fertility of soil and sustain it at high level.

Three crops raised from the same land in a year for two successive years are shown below :

1st year—Jute followed by transplanted aus paddy followed by wheat.
2nd year—Aus paddy (line sown) followed by Kalai for fodder and gram followed by potato.

The yield of Jute was 33 mds. per acre, that of transplanted aus paddy 35 mds. per acre and that of wheat 20 mds. per acre. The yields per acre of the

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three crops raised in the second year are 25 mds., 250 mds. and 200 mds. respectively.

It will be seen from above that it is possible to increase the production per acre considerably. From actual experiments we have found that it is possible to make a net income of Rs. 1,000/- to Rs. 1,500/- per acre from different triple cropping programme.

8. SRI JAGANNATH HOTA (Cuttack) :

For maximization of yield, apart from the work and results on land and land productivity and the methods involved in extending the same to the cultivators we have to take into consideration the following main points from the cultivators' point of view.

(1) *Organization of better facilities for financing Agriculture* : Improved methods leading to maximization need more investment of money. Adequate arrangement needs to be done in this direction. Low investment cannot lead to more production.

(2) *Mechanization leading to labour replacement* : Labour was very cheap in the past and the present labour wages are considered somewhat high but time is coming when the wages will rise much higher. A cultivator knows that timely sowing and other agricultural operations will have magnificent results but he would not be able to carry out his operations in time because of lack of labour. We have therefore to adjust ourselves in this direction.

(3) *The cultivator as a manager* : Our cultivators are not well educated. If educated they do not stay in the line because it is less paying than many other professions. There has to be devices, therefore, to attract intelligent and educated people to the field of agriculture. A cultivator from his earnings should be able to own a good house, a comfortable and quick conveyance and should be able to pay for good education for his children and for the maintenance of the health of his family.

The fixing of ceiling on agricultural holdings with the idea of providing a modest living for the farmer will not attract intelligent people to agriculture. As a matter of fact if a farmer, and his family can manage with their own labour and with the help of suitable machinery certain piece of land he should not be deprived of the same by way of fixation of ceilings.

In the matter of getting income from agricultural enterprises Dr. Sen, our President, has suggested with the help of data obtained from certain parts of Burdwan that it is possible to expect an average proprietor-farmer-manager-worker of India to get an average income of Rs. 600—1,000 per month from an average holding of 10—15 acres.

9. DR. B. CHOUDHURY (New Delhi) :

It is suggested that efforts should be made to modify the cropping pattern and the food habit of the people. Agricultural crops which produce 10 to 20 times more than the general cereal crops both in quantity and nutritional quality should occupy more and more area. These are vegetable crops. To meet the demands of the growing population it is but essential that more area should be put under vegetables and people should acquire the habit of taking more of vegetables. It is well known that better seeds, better agronomical and plant protection methods can increase the yield per unit area. In addition to these two other methods are suggested. The first is use of hybrid F_1 seeds in crops like tomato, brinjal, onion, bhindi and cucurbits where 30 to 200 percent increase has been recorded. The

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use of male sterile lines to decrease the cost of hybrid F_1 seeds is also suggested. The second suggestion is the use of plant regulators in vegetables like tomato, brinjal, cowpea and cucurbits. For maximisation of agricultural production we must have to pay more attention to vegetable crops which has so far been neglected in our country.

10. DR. S. GOVINDASWAMI (Cuttack) :

For Maximisation of Agricultural production the primary requisite is the availability of high yielding varieties. In this direction, in rice, many high yielding strains have been evolved both by selection and hybridisation. The *indica* × *japonica* hybridisation programme initiated at the central Rice Research Institute, in recent times, is a significant advance in this direction. But even some of our local varieties (especially collected from some unexplored areas) are capable of giving high yields. This is also evident from the fact that many of the high yields obtained by Krishi Pandits in crop competitions are through the use of local varieties, in combination with other suitable cultural methods. Therefore the evaluation of our indigenous varieties for high yields is very necessary. These varieties can be directly introduced with profit for boosting up yields.

Work done by Dr. Richharia and his associates at the Central Rice Research Institute has shown that tiller separation and stubble planting can give increased yields up to 17 to 61 per cent, in rice. This technique also can profitably be used for maximisation of rice yields.

11. PROF. J. J. CHINOY (Ahmedabad)

The problem of maximisation of crop production can be divided into two facets : (1) Research work to determine the optimum combinations of factors governing crop production for obtaining maximum yield, and (2) application of results of research to farm practice on country-wide basis.

As the second facet involves a number of problems of agricultural economics it is not dealt with here. As regards determining optimum conditions for getting maximum crop yield per acre it may be pointed out that none of the speakers at the symposium had stressed the importance of complex factorial experiments which take into consideration the physiological interactions of major factors like manuring, watering, spacing, time of sowing and others. Even upto the present day single factor experiments are generally laid out on fields of agricultural research institutes and stations.

A survey of experimental work done in India reveals that there is paucity of experimental evidence on the optimum combination of factors and their interactions for the numerous crop plants and their varieties growing in this country of ours. Consequently the extension work for introducing correct farm practice has failed. A number of instances of such failures can be cited. One well known example is "the Periodic Partial Failure of American Cotton" in undivided India. This problem was solved by the late Professor R. H. Dastur by applying the technique of complex factorial experiments and supplemented by late Professor F. G. Gregory's method of growth analysis.

In conclusion it is suggested that agricultural research institutes and stations should include on a large scale complex factorial experiments on different crop plants supplemented by growth analysis with a view to determining the optimum combination of factors and their psysiological interactions. Data from a large number of such complex field experiments can only entitle them to tender advice to the farmer.

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12. SHRI ANIRUDHA MISRA (Cuttack) :

Different speakers have spoken about different aspects but one--the problem of weeds. Weeds are there since the beginning of Agriculture. Crop plants and weeds compete for same type of requisites for growth—i.e. nutrition, space, light etc. So unlike Pests and Diseases which are parasites on crop plans—the weeds are the brethren of the crop plants and compete for same needs. In this competition weeds win.

The loss due to weeds alone is more than what it is due to Pests, Diseases, Birds and Animals and animal diseases put together. We do not have any statistics for this. In U.S.A. they have found out that it is 40-50 per cent on an average and may be cent per cent. The weeds work as a double edged sword. They reduce the crop yields and cause farmers to spend more to remove them.

There is shortage of labour in the villages due to developmental work of Five Year Plans. Cost of removal of weeds has gone up from 50 per cent or more of total cost of cultivation. In Europe and America large scale chemical control has been started by Government or by Crop Insurance organisation. It is high time that we devote more of our time and resources to study and solve this problem of weeds and by that alone we can increase yields by 40—50 per cent.

13. N. K. CHAKRABARTI (Cuttack) :

By controlling the spread of the diseases yield of the crop can be increased to a considerable extent.

1. Helminthosporium disease of rice can be controlled by spraying/dusting fungicides. Experimental records in West Bengal show that helminthosporium can be controlled by spraying rice crop with 'Perenose' (copper fungicide) in a large area in cultivator's field.

2. Resorting to 'low volume' spraying the cost of fungicides can be reduced to 1/5th of the cost under 'normal volume' spraying of rice crop, and this is economical from the point of view of 'net' return of the yield obtained by controlling the disease through spraying fungicides.

3. Judicious application of fertilizers (nitrogenous) is necessary to minimise the incidence of diseases.

4. Varieties resistant to the diseases should be used wherever available. A number of rice varieties resistant or moderately resistant to blast and helminthosporium are available.

5. Establishment of disease forecasting units in different areas are necessary, so that cultivators can be given warning regarding the appearance of diseases, so that the plant protection measures can be resorted to in time.

14. SRI G. C. SEN GUPTA (Cuttack) :

The main reason why the Agricultural Scientists have failed to make their impact on food production and national development is the lack of trained personnel in the extension organisation. Unless the extension organisation has adequate staff trained up to the gradute level in different branches of Agriculture it will not be possible to educate the farmers in improved practices of Agriculture. There can be only better dissemination of scientific knowledge to the cultivators through the extension staff having well trained technical staff. When the farmers are convinced by well planned demonstration they will adopt modern scientific methods which will contribute a great deal towards this maximisation of yield.

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15. SRI P. ISRAEL (Cuttack) :

Control of pests in rice crop is an important contributory factor for "Maximisation of Agricultural production". By adopting a rational method of controlling stem borers by spraying insecticides to synchronise with the emergence of broods, the incidence of stem borers can be reduced by 84% and the yield can be increased by 54%. Whatever methods are used for maximisation, adoption of plant protection measures gives still higher yields.

In an experiment at the Central Rice Research Institute, the following results are obtained :—

	Yield per acre
Unmanured	... 971·00 lbs.
Manured (40 lbs. Nitrogen and 32 lbs. P_2O_5) ...	... 1791·00 ,,
Manured and sprayed	... 2368·00 ,,

In breeding varieties for maximisation, it is desirable that characters responsible for resistance to pests should be taken into consideration. Experiments at the Central Rice Research Institute indicated that the less susceptible strains are characterised by thick bands of lignified sclerenchymatous tissue in their stems with narrow lumen. In the more susceptible varieties the sclerenchyma is poorly developed.

16. SRI SITARAM MISRA (Bhubaneswar) :

Maximization of Agricultural production should also include quality of the food i.e. besides the yield in quantity equal importance should be placed on the food value of the crop, and accordingly breeding programme should be followed.

17. SHRI K. PULLAIAH (Bhubaneswar).

While maximising production qualitative factors such as size, taste, colour, aroma, appearance etc., and the economic aspects also should be taken into consideration. How, where and when to maximise the agricultural production are some of the problems confronted by the scientists to-day. Both "vertical" and "horizontal" ways to maximisation of production should be done simultaneously. The "vertical" or intensive method of maximisation includes use of improved seeds, implements, more manures, fertilisers and irrigations in addition to the use of improved technique and agronomical practices. In this case the land is kept constant and more labour and capital are added for maximising yields. In "horizontal" or extensive method more land is brought under plough by way to reclamation and usage and all the factors of production or resources are simultaneously used.

Maximisation of production must occupy the maximum financial gains to the cultivators and the laws of economic returns should also be observed. Plant protection does not form one of the methods to maximise production as stated by Dr. Narayanan but prevents damage to a crop or product. Hence it need not be universally adopted or the entire area covered since it adds more cost to the production. But effective steps should be taken only where a pest or disease appears.

Another point is that the cost of the increased yield should not exceed the market cost of the same product. Effective use of land and efficient use of labour, capital and capital equipment are the primary requisites in maximising agricultural production.

The discussion ended with a vote of thanks by the President given to the contributors and speakers.

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II. WATER REQUIREMENTS OF CROPS

Chairman : PROF. P. K. SEN (Calcutta)

1. PROF. J. J. CHINOY (Ahmedabad) opened the discussion.

Ensuring adequate supply of water for the optimum growth and development of crop plants is one of the important problems confronting cultivators in arid regions of our Country. As the amount of water available for irrigation is generally limited in quantity it is necessary to regulate its use scientifically so as to obtain the best economic return.

A little confusion appears to have arisen in the use of the term 'water requirement' by different workers. It is, therefore, necessary at the outset to obtain a correct perspective of the subject under discussion. The term 'water requirement' of plants was first used by Briggs and Shantz (1914) to denote 'the ratio of the weight of water absorbed by a plant during its growth to the weight of the dry matter produced exclusive of the roots.' This term has replaced the term 'Coefficient of Transpiration' suggested earlier by Hellriegel (1883). Maximov (1929) considers the phrase 'efficiency of transpiration' (Productivität der Transpiration) which was originally suggested by Ivanov (1913) as more suitable because 'the determining process is transpiration and the determined the amount of dry substance'. It is more convenient because an increase in the figure denoting the value of the ratio actually corresponds to an increase of efficiency per unit of water used, while according to the usual terminology, an increase of efficiency is accompanied by a decrease in the figure representing the ratio. He has expressed 'efficiency of transpiration' by taking the ratio of the amount of dry substance produced by the plant for every kilogram of water expended. Thus the reciprocal of 'water requirement' multiplied by 1000 will give the value of 'efficiency of transpiration'. Very often experiments for determining the duty of irrigational water for different crop plants are also termed as 'experiments on water requirement of crop plants.' This leads to confusion especially when relationship between the 'water-requirement' as defined by Briggs and Shantz and the level of water duty is to be established. It is, therefore, proposed to use the term 'water requirement of Plants' exclusively as suggested by Briggs and Shantz.

A review of work on water-requirement of plants clearly brings out the fact that this so-called index of drought resistance in plants is not a constant because it is mainly dependent upon the amount of water transpired by the plant. All the factors influencing transpiration and other physiological processes of the plant would therefore influence the magnitude of water requirement. After a prolonged investigation Maximov and his collaborators came to the conclusion that a large number of plants growing in dry regions had exceptionally high rate of transpiration. Thus such plants were no economisers of water but wasters.

Considering the above mentioned facts it appears that the most fruitful line of research in this subject is to determine the most economic use of irrigation water for optimum crop production. Numerous instances in published work as well as in the records of various research stations of our country can be cited in which different levels of watering have been studied without taking into consideration the nutritional level of the soil, time of sowing and spacing. Such single factor experiments cannot give a correct estimate of the irrigation water required by the crop under different soil and climatic conditions because they are based on the erroneous assumption that each of the contributing factor has an independent action of its own on crop production. Optimum combinations of different agronomic factors can only be obtained by carrying out complex factorial experiments. Another advantage of such complex factorial experiments is that the interactions of factors can also be studied. Another important aspect of the complex irrigation experiment is the technique of growth analysis developed by Professor F. G. Gregory

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and his co-workers. Growth analysis has been successfully applied to complex field experiments for obtaining further confirmation of yield data.

Many instances can be cited of the successful application of the above-mentioned techniques and benefits accruing to the cultivator from the application of results of these experiments. One such outstanding example is the solution of the problem of irrigated cotton in the Sudan by Prof. F. G. Gregory. Practical application of the results of Cotton Physiological Scheme sponsored some years back by the Indian Central Cotton Committee under the guidance of Professor R. H. Dastur at Lyallpur (in undivided India) is also another example of what can be achieved by following the proper technique.

2. SHRI A. P. BHATTACHARYA (Roorkee) :

If we trace the history of civilization of mankind we find that the culture and care of crop plants marked an important step in his progress, for he had then crossed the primitive stage—leading a nomadic life and hunting and fishing for a living. When man started growing plants, he needed a home and from there onwards he was on the path of civilization. Land was there for the asking, and man could grow enough food for his tribe.

Of late, however, the pressure on land started growing, while the means of subsistence (from crops) could not grow at the same level. This is really the era when we have been forced to think about maximizing food production.

Everyone knows how essential water is for crop production. It is also well known that the best source of water is from natural precipitation. When, however, this is not sufficient to meet with the watering needs of the crop or its behaviour is erratic or subject to fluctuations during the growing season that we resort to supplemental irrigation for fulfilling the water requirements of crops.

In the case of deficient watering, crop production naturally suffers. It is, however, not always appreciated by the layman that when more water is applied for irrigation than necessary, the excess is not retained by the plant. This escapes to the ground water table, carrying with it in solution valuable plant food which is thus wasted. Proper water management is therefore a prerequisite for successful irrigation practice and consequential crop production.

For the determination of water requirements of crops, there can be several possible methods out of which experimental determination is the most direct and accurate. This was adopted for the determination of water requirements of three principal crops of Uttar Pradesh, namely, rice, wheat and sugar cane, work on which was initiated in 1942-43. In this series of experiments, an attempt was made to isolate the effect of watering, keeping all other factors more or less constant, in order to arrive at the optimum combination of the level and frequency of irrigation for obtaining the maximum yield.

Several empirical formulae were also tried for the assessment of water requirements from climatological data. Blaney-Criddle formula was found to be the most practical and consistent for adoption.

Out of the net cultivated area in the country, 20 per cent is irrigated, where the wasteful use of water is being practised freely. This is minimizing the yield by at least 20 per cent, the enormity of which can well be imagined. This works out to the order of several crores of rupees. For all irrigated regions of the country, it is therefore imperative that immediate steps should be taken for taking to proper water management, prerequisites for which are the initiation of an extensive series of experiments on water requirements of all important crops and the dissemination of the knowledge to the cultivator who should be induced to make the correct use of water for irrigation, which will augment his crop yield, improve the quality of the crop and revolutionize the economy of the country which will be converted into a completely self-sufficient area (in food).

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3. DR. S. K. MAJUMDAR (Cuttack) :

The study of the water requirement of any particular crop plant has two major implications; (a) *Agronomical*—where the nature of the soil, manuring, crop variety and its duration are studied in relation to meteriological factors and available irrigation facilities, and (b) *Physiological*—where those intrinsic factors are studied that enable a plant to withstand periodic drought conditions with the least or no reduction in the yield. The present discussion concerns itself strictly with the latter aspect of the study with reference to rice plants.

It has been reported that an amount of 25″-30″ total rainfall is required for a successful crop of a rice variety of about 125-135 days duration. The problem of drought is, however, encountered in a rainfed upland crop in a season when the distribution of rain is unfavourable and plants are subjected to drought conditions at a critical time in their growth cycles. Earlier reports on morphological adaptations such as root system, stomatal frequency and transpiration rate in a variety of rice do not indicate any correlation between these characters and actual drought resistance capacity of that variety in terms of final yield under periodic drought. The physiological basis of drought resistance in rice, therefore, must be sought elsewhere.

It was reported that heat-stability of chlorophyll in a variety is an index to its drought-resisting capacity. Unlike a drought-resistant variety, the yield of a drought-sensitive variety is drastically reduced when grown under periodic drought conditions. It is, therefore, conceivable that chlorophyll synthesis and photosynthetic efficiency, which are responsible for satisfactory yield potential of a variety, have some close relationship with the actual drought-resisting capacity of that variety in terms of final yield. Results of the work in progress at Central Rice Research Institute, Cuttack, indicate that the heat stability of chlorophyll of a rice variety is correlated with its drought-resisting capacity.

4. DR. S. D. NIJHAWAN (Ludhiana) :

1. Water logging. Water logging in the Punjab is not only due to excessive use of it by cultivators but due to seepage from the canal bed and due to upsetting of natural drainage due to construction of railway lines, roads and canals.

2. No mention has been made to relation of soil to water requirement of crop. It is very important problem. It will help us in finding out the optimum quantity which should be stored in the soil to get maximum yields.

3. Time of application of irrigation water to different crops. It is another important problem. When irrigation water is applied at certain stage of the growth of a crop, it is possible to obtain maximum yield of a crop. This work has been done in the case of bajra, guara, wheat and gram.

4. It is a wrong conception that the water requirement of crops is increased by the application of fertilisers.

The President thanked the contributors and speakers.

III. RECLAMATION OF WASTE LANDS

Chairman : PROF. P. K. SEN (Calcutta).

1. PROF. N. R. DHAR (Allahabad) opened the discussion.

Prof. Dhar pointed out that the Statistical Department of the United Nations unequivocally declared for three consecutive years from 1956 that India was the hungriest country in the world, as the caloric intake is of the order of 1620 per

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capita and the animal protein consumption per person per day is only 5·6 gm. as against 28·00 calories and 30 gm. needed. Prof. Dhar also remarked that experiments carried on in Europe and America show that one kilogram of nitrogen applied to crop production produces 15-16 kilograms of cereals, whilst in India, paddy production is ten times the weight of nitrogen added to land. The response to phosphate and potash of crops is almost one-fourth of that of nitrogen. The world production of cereals to-day is 1,000 million tons, good food production is 700 million tons and fodder production is 1,600 million tons. For producing these materials in the whole world, not less than 250 million tons of nitrogen as nitrogenous compounds are necessary, but the world supply of factory nitrogenous fertilizers is only 8·8 million tons. In India to-day 70 million tons of cereals are being produced; this requires approximately 7 million tons of nitrogen. But Sindhri and other factories are manufacturing not more than half a million ton of nitrogen as chemical fertilizers. Hence chemical fertilizers are completely inadequate to meet the nitrogen need of Indian and world agricultrue. The Chinese and Japanese do not waste any organic matter and utilise weeds, animal and human dung and other wastes in crop production along with chemical nitrogen. It has been observed all over the world that artificial nitrogenous compounds are more effective when the soils are rich in humus (organic matter). This is the reason why the response to crops of nitrogen seems to be greater in Europe than in India. Hence for intensive cultivation a mixture of inorganic nitrogen and organic matter have to be utilised. Moreover, Dhar and coworkers have observed experimentally that the oxidation of soil humus is increased by applying to soil organic and inorganic nitrogenous fertilizers and manures. The chief source of the soil nitrogen is the slow photo chemical and thermal oxidation of organic matter aided by sunlight and phosphates.

For over 30 years, Dhar and coworkers have developed a method of land fertility improvement and reclamation of saline and alkaline and waste lands all over the world by the application of all types of organic matters mixed with calcium phosphates. As organic matters, molasses, pressmud, cane leaf, cane trash, weeds, grasses, straw, leaves, *kans*, water hyacinth, *cactus*, sawdust, peat, coals, etc., have been profitably applied in fixing atmospheric nitrogen in the land and increasing the humus capital. For phosphates, bone, superphosphate, all basic slags from our expanding steel industries (Tata, Kulti and Durgapur) containing 4 to 10 per cent P_2O_5, plenty of lime, magnesia, manganese, potash and other useful plant nutrients have been utilized with great success. By this method large areas of saline and alkaline and waste lands have been reclaimed in Rajasthan, and other parts of India. There is no need to powder the slags but in small lumps when mixed with organic matter the slags are dissolved to soluble phosphates, calcium and magnesium salt by the carbonic and organic acids generated in the oxidation of organic matter. Phosphating of organic matters is certainly a very big step in improving the fertility of land permanently and reclaiming alkali and acid soils of the world. The organic matter like glucose present in molasses, cellulose and lignin present in straw, leaves, etc., undergoes oxidation when mixed with soil ($C_6H_{12}O_6+6O_2=6CO_2+6H_2O+673K$ cal.). The energy liberated decomposes water molecules present in soils into atomic hydrogen and OH radical ($H_2O+112K$ Cal$=H+OH$). The atomic hydrogen being highly reactive directly combines with nitrogen forming ammonia and thus the nitrogen status of the land is enhanced by organic matter. In this process sunlight is absorbed and leads to greater fixation of atmospheric nitrogen. Calcium phosphates also improve markedly nitrogen fixation by applying organic matter not only when ploughed in land, but also Dhar and coworkers have observed that the total nitrogen content of ordinary composts is 0·5 to 1 per cent, whilst phosphated composts contain 1 to 1·2 to 2 per cent total nitrogen. Light enhances the nitrogen content of composts. So does phosphates.

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2. Dr. S. P. RAYCHAUDHURI (New Delhi).

Land which have either gone out of cultivation or have never been brought under cultivation may be classed as waste lands. Under this class may be placed (1) barren and uncultivable lands and (2) cultivable wastes. The problem of reclamation of waste lands involves bringing mainly the cultivable wastes under cultivation.

The population of India according to 1961 census is 438 millions. The per *capita* cultivated land area is 0·73 acres, whilst cultivable waste land (excluding fallow) *per capita* is 0·127 acres. The *per capita* cultivated land area in India is very low, as compared with other countries, with the exception of China. On the top of this, the productivity of Indian soils is at a very low level with the result, that a large percentage of our population is either underfed or is suffering from malnutrition. The increased production of food grains aimed at in the Third Five Year Plan over that achieved in the Second Plan (79·3 millions) is 20·7 million tons.

The total cultivable waste lands in different states in India is about 54·9 million acres. The cultivable waste lands, if brought under cultivation, can be one of the important factors for augmenting the Country's production. The chief reasons for leaving such lands uncultivated are :—

(1) Deep rooted grasses and weeds.
(2) Unhealthy conditions, chiefly due to malaria.
(3) Lack of drainage.
(4) Low fertility of the soil.
(5) Lack of water supply.
(6) Salinity and alkalinity.
(7) Damages by wild animals.

Some area of the cultivable waste lands infested with deep-rooted grasses and weeds were reclaimed by the Central Tractor Organisation and by the states by tractor ploughing. For planning reclamation work it is necessary to ascertain what proportion of cultivable waste lands can be brought under plough, and under what conditions. A rapid preliminary survey of all such areas will be helpful in drawing up of project plans for this reclamation. More detailed survey for specific areas may then be undertaken to draw up the execution plans for individual blocks. For carrying out rapid preliminary survey of the wastelands the technique developed in the Maharashtra State may be used. In this system the land is divided into four classes :

A Class :—This class of land is one which is suitable for cultivation without special practices. It is nearly level land, well drained and should produce at least an average crop. No special soil conservation measures are needed except following the usual methods of good cultivation.

B Class :—This class of land is suitable for cultivation with intensive cultural practices. The land slope may vary from 16 to 8 per cent and should have adequate depth of soil with a minimum of 6". The land may have been affected from ordinary sheet erosion to gully erosion.

C Class :— This class of land is not suitable for cultivation and requires severe restrictions in its use from soil and moisture conservation point of view. Such lands are of steep slopes of more than 8 per cent, rough, highly eroded, with very little soil left. Such lands are suitable for afforestation. This class of land should be capable of giving a good yield of grass.

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D Class :—This class of land has less than 6″ of soil with highly undulated terrain and uneconomic to develop.

While the class A land may be straightway brought under irrigation without any soil conservation measures, it is the class B land which may be profitably brought under cultivation. In recent years the Ministry of Food and Agriculture set up a Wasteland Survey and Reclamation Committee for locating areas where large blocks of such lands are available for reclamation and settlement and also suggest suitable methods for reclamation and colonisation. This Committee is bringing out the reports of individual states which contain very useful information about the occurrences of such lands in big blocks in the states. A rapid survey for the location of smaller sized cultivable wastelands is also under the consideration of the Government of India.

The techniques of reclamation of the B class cultivable waste lands have been worked out but needs further study for making the techniques more effective.

3. DR. S. K. MUKHERJEE (Calcutta).

In West Bengal there is 2·97 million acres of land which are not available for cultivation. These comprise of forests, ravine, eroded lands and lands not suitable for cultivation, but can be brought under cultivation with suitable measures. Lands which are fallow, mostly occur in small blocks of less than 50 acres, but few do exist which are quite large and are now either barren or support some vegetation which is sparse.

The reason for these lands lying fallow can be either due to lack of water resources or due to salinity. The land which suffers from drought has long been undergoing erosion due to the heavy rainfall in these regions. Experiments show that they need conservation measures and at places need suitable amendments to correct the acidity formed. At places the rockbed or the underlying morum has been exposed as a result of the entire soil cover being eroded out due to different types of erosion. Experiments on reclamation show that it is essential to first check further loss, by suitable conservation measures and then try to develop these as forest lands. Partially eroded lands are to be first examined for their soil depth and nutrients needed and then to be put under different crops, depending upon the suitability of the land for the particular crop. The outcome of the reclamation of such waste lands may be bleak, because even if they are reclaimed or brought under cultivation, they may not produce an economic yield for the first few years.

In the saline tract we have quite a large area under sea water damaged lands which get submerged during high tide and come out of water during low tide. They sustain a type of vegetation, semi aquatic in nature and not much woody. At present such lands are being formed as a result of deposition of the silt interpersed with the salt layer brought down by the tidal flow and ebb. Experiments indicate that if we embank these tidal waters to prevent the high tides getting in the areas it may perhaps present a suitable area for reclamation. In West Bengal such reclamations are being experimented by the help of embankment drainage through sluice. The nature of drainage is either open or tiled drainage, depending upon the suitability of the area to be reclaimed. The water table is maintained at a suitable depth by the help of these. Under the tiled drainage system which are opened up in small rivulets which, in their turn, get into the sea by a sluice. It has been found that these saline soils lose their salts easily when rain falls and in about three to four years, become suitable for normal khariff operations. They invariably in the first year support a good, though patchy, paddy crop.

Use of soil amendments like gypsum has been found of not much practical use. The reserved calcium present in the soil is sufficient to convert the sodium

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soil gradually into a good calcium soil. We expect that the entire estuarine areas of Sunderbans can gradually be reclaimed from the sea by this process, as our experiments indicate in certian regions of the coastal soils of West Bengal.

4. Shri A. K. SARKAR (Calcutta).

With increasing population and against the background of limited area under cultivation, the problem of food supply is becoming acute in India. It has necessiated, extending cultivation into sub-marginal waste lands, which are low in fertility and have to be improved by modern farm practices.

Among cultivable waste lands of West Bengal the extensive span of lateritic uplands in the areas bordering Bihar and Orissa are of considerable importance. Here the cultivation is poor and is restricted to the rainy seasons only. There is no scheduled crop rotation; a single crop a year is general rule.

The pH varies round 5 and phosphates get fixed chiefly due to gradual dissolution of iron and alminium oxides. Deficiency of organic matter in addition to the continuously deteriorating nitrogen level is a common feature for the soil of the region.

With a view to finding out a proper crop rotation schedule for this area commensurate with an economical fertilizer programme, the Department of Agriculture, Calcutta University, has started work at Seva-Bharati Farm, Dist. Midnapore, which is situated in the lateritic area, from 1957. In course of investigation the beneficial effects of phosphates and lime on crops, specially on legumes, have been noted. The work is now in progress.

5. Dr. B. N. SAHU (Bhubaneswar).

Necessity :—Population is increasing. Personal income per capita and gross national product will increase as envisaged in five year plans. In the light of the rapid growth productivity of land must be increased. How rapidly and by what means this increase will be given effect to? Urban and suburb development is encroaching on agricultural land. Hence is the importance of reclamation of waste land.

Means to be adopted :—Wild life is largely an Agricultural Crop. In U.S.A. more than half of land area in the farms are used for production of food, fibre and wood products. Rest of the land produce most of the wild life that people hunt, watch or otherwise enjoy.

(1) Waste land can be converted into good wild life habitat. Land use may be adjusted to their capabilities. So such lands can be left in a natural condition instead of being destroyed by an attempt at cultivation.

(2) Wet lands and pot hole areas need not be drained out for cropping purposes. They prove unprofitable for cultivated crops. These can be used for wild life such as ducks, muskrats. Such lands should be developed with natural food and cover. It should be designed as nesting area for ducks and other birds or to attract and hold migrating water foul by food planting. Areas can be drained during summer. Grain crops to be grown and then flooded to attract water foul. Sudan grass, Johnson grass, Jobs tears, Cattsels, Buttonbush can be grown to provide semiopen water landing areas for the water foul. Pheasants, pigeons and doves will increase. Such areas can be auctioned for hunting migratory birds.

Earthfill dams and low-concrete and pipe structure can be built to control the water level and provide for training wherever necessary.

(3) Marginal lands can be utilised for tree planting. Trees will change the rough unsightty areas into a place of beauty and a heaven for wild creatures. Rabbits, quail, doves and pheasants patridges make the area their home.

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Along with grass vegetation brouse-type of vegetation may be encouraged. The increase in brouse will favour deer. It has been seen that cattle prefer grass, sheep and goat prefer forbs while deer like brouse plants. Tree planting, brush control and seeding with grass will encourage deer and quail breeding rabbits, squirls and pheasants will be plentiful.

(4) Sportsman club may be formed. Hunting bases may be granted. Such bases will form a good source of income. Good news will travel fast. Hunters will come from far and near.

(5) Small woodlots can be created. In the Tannesse valley of U.S.A. the marginal lands are being planted with Pine trees. A ten year programme has been taken up in Bowater County. The Pine trees will be utilised for pulp-making for production of news prints. In India there is a great shortage of news prints. To meet this shortage such a programme as that of Bowater County may be taken up for planting Casurina, bamboo, sabai grass in the marginal lands.

Organisation :—Field Service for utilisation of waste land may be formed by Government. In Israel Drainage Department of water planning for Israel Ltd. has been formed for dealing with water problem. This is a corporation in which the Israel Government is one of the major stockholders. So a waste land service of land utilisation Board may be formed in the line of Drainage Department of water planning of Israel. The method they will develop will be of local character. Local Councils may be formed. The waste land utilisation service will disseminate information and services related to waste land utilisation. The staff for each district will consist of an agronomist, laboratory assistants, field technician and a biologist. The staff will be under the control of Zilla Parishad. This organisation will be financed from their local taxes.

6. SHRI S. C. MANDAL (Ranchi).

Acid soils cover a large acreage in Bihar to the extent of 4 to 5 million acres and a considerable fraction of these soils is lying waste. These soils have very low productivity. A local paddy is grown year and year after with very poor yields. Other upland crops, e.g., maize, juar, groundnut, *rahar,* cotton etc. are not grown extensively as these soils support very poor crops even if they are supplied with NPK fertilisers. A series of experiments were started at Kanke Farm (Ranchi) in 1956 and carried over for five years with a view to making these soils productive. Lime was the principal soil amendment that worked out very successfully. With lime and fertilisers very good crops of groundnut, cotton, rahar, maize, juar, etc., can be grown. Some crops, however, did not respond to lime, the most prominent among them being paddy.

7. DR. R. N. SINHA (Banaras) spoke on the nitrogen fixation property of certain alagae and on their usefulness in the reclamation of alkaline soils of Uttar Pradesh.

The President thanked the contributors and speakers.

IV. UTILISATION OF AGRICULTURAL WASTES

Chairman : PROF. P. K. SEN (Calcutta).

1. DR. K. C. GULATI (New Delhi) opened the discussion.

The Government of India appointed a committee to investigate the efficient utilisation of waste food products and farm wastes. This committee made a detailed

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survey of agricultural wastes and made suitable recommendations for their uses. According to this committee agriculture has to be run as an industry and for this investigations not only on agricultural food wastes should be taken up but also on the by-products of agriculture which are not utilised economically at present and do not bring suitable return to the farmers. This committee besides other materials recommended that investigations should be taken up on certain oils and oil cakes e.g. castor cake. The neem seed cake which is at present used extensively as a manure missed the attention of this committee.

There are conflicting claims in literature on the efficiency of neem seed cake as pesticide against certain pests of agriculture. Investigation in this regard is likely to yield fruitful results.

Among the non-edible oils the use of neem oil for industrial purposes occupies an outstanding position. However, its odoriferous character and higher percentage of unsaponifiables makes its refining prerequisite to its use as a substitute for edible oils for use in industry.

The problem of its high cost of refining may to some extent be eased by developing more remunerative uses for its major by-product/co-product : neem seed cake.

At the Indian Agricultural Research Institute, New Delhi, the neem cake is being investigated from the point of view of its use as a source of better manure and cattle food; a source of sulphur bearing amino acids and a source of pest contril chemicals against certain pests of agriculture.

2. SHRI HARPAL SINGH (Gwalior).

As stated by Dr. Gulati, it is true to some extent that there is no material to be called as waste and specially molasses which is used in fermentation industry. However, on places where this material cannot be used for fermentation it can be very nicely utilized as a manure as suggested by Dr. N. R. Dhar of Allahabad. In using this material it is but necessary to take precaution that it should be used in the soil at least 3 months before sowing or at the time of irrigation. During our experiments on molasses irrigation it was found that it helps the sugarcane crop greatly with respect to yield and quality. The other beneficial way is to use it as a dilute solution for spraying and we found that by doing so there is an improvement in cane quality. For using it in fermentation industry or in Agriculture there is a problem for its transport and some experiments were done to solidify the molasses so that this problem may be solved, but this could be solved partially and further attempts are to be made in this direction.

3. SHRI S. C. MANDAL (Ranchi).

In the arable lands of Ranchi district a weed is extensively grown in the kharif season. This weed is the most dominant amongst all weedy vegetablts in an arable upland in this district is kept fallow. The weed grows so vigorously that one feels tempted to find out if it has any economic use. The Agronomy and Animal Husbandry Departments of Ranchi Agricultural College have prepared a very good silage out of this weed. It can also be fed to cattle if mixed with other more palatable feeds. The milk production is not affected adversely when it is fed to cattle as a component of green feed mixture.

The discussion ended with a vote of thanks by the President given to the speakers.

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I. INTERRELATION BETWEEN VITAMINS AND HORMONES

Section of Physiology

Chairman : DR. G. C. ESH (Calcutta).

CHAIRMAN'S INTRODUCTORY REMARKS :

One of today's most challenging problems in cellular physiology is how the several hormones may operate at the cellular level to produce the changes in metabolism in specific organs which are evident as changes in growth and activity. The endocrine control includes an adjustment of metabolism through the interaction of numerous hormonal activity in specific biochemical or biophysical areas to produce optimum substrate concentration, adequate enzyme activity and appropriate work performance in all organs and tissues in a variety of physiological and pathological states. Both the synthesis and degradation of hormones are dependent on enzymes and perhaps all the physiological effects of hormones are brought about by their regulation of specific enzymatic reactions within the cell. Since various vitamins particularly B vitamins are known to play great roles in these enzymatic reactions as part of enzymes or coenzymes a balance in the interactions of vitamins and hormones is likely to occur in maintaining the integrity and functioning of the body mechanism. Although the exact mechanism is not yet known both vitamin A and vitamin B_{12} play a great role in the elaboration and function of thyroid and pituitary hormones. Vitamin B_2, pantothenic acid and ascorbic acid seem to be related to the secretion, elaboration and functioning of adrenocorticoid hormones and consequently of pituitary hormones. Present day studies indicate that even vitamin A whose mode of action in the body is not yet known seems to be related to the production of glucocorticoid hormones since vitamin A deficiency tends to lead to a degeneration of adrenal cortex cells and consequently to a depression in gluconeogenesis through an impaired production of glucocorticoid hormones. We have got many experts here and it is expected today's deliberation will be a fruitful one on such a vital problem in metabolism.

1. SACHCHIDANANDA BANERJEE (Bikaner) : *Interrelations of vitamin C-nutrition and insulin secretion.*

Vitamin C-deficiency produced in guinea pigs and rhesus monkeys by feeding a scorbutogenic diet was associated with imperfect carbohydrate metabolism. The scorbutic animals showed diminished glucose tolerance, diminished deposition of liver and muscle glycogen, decreased insulin content of the pancreas, degranulations of the beta cells of the islets of Langerhans, decreased hexokinase activity of the liver and muscle and decreased oxidation of citric acid in the tissues. All these changes can be attributed to the diminished secretion of insulin in the scorbutic animal. The changes observed in the scorbutic animals as described above could be reversed by the simultaneous injections of small doses of insulin from the tenth day of feeding the scorbutogenic diet. This further indicated that scurvy is associated with hypoinsulinism. It is, however, not clear how insulin formation is associated with normal vitamin C-nutrition. In the tissues of the scorbutic animals there is accumulation of dehydroascorbic acid which, however, is absent in the tissues of normal animals. Glutathione content of tissues is diminished in scurvy. Toxic substances accumulate in the tissues of scorbutic animals due to imperfect oxidation of phenylalanine and tyrosine. It is possible that sulfhydryl enzymes which are used for the detoxication of toxic substances produce an increased demand on glutathione. This tripeptide contains cysteine which is a part of the insulin molecule. The synthesis of insulin, therefore, is likely to be deficient due to the short supply of glutathione in scurvy.

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2. A. SREENIVASAN (Mysore) (*in absentia*) : *Vitamin B_{12} and Experimental Thyrotoxicosis.*

The primary manifestation of thyrotoxicosis has been observed to be an impaired ability for retention of vitamin B_{12} by the tissues. Thus, there is a pronounced decrease of the vitamin in liver and its mitrochondrial fraction. A similar lowering of the vitamin in blood is accompanied by a loss of erythrocyte vitamin to the plasma. These observations are suggestive of *'in vivo'* osmitic damage to the structure of the cell and cellular particles. Such a damage to mitochondrial morphology is also evidenced by decreases in optical density, magnesium content and E_{260} material in isolated mitochondria from thyrotoxic animals. There is a further lowering of rate of release of intramitochondrial nucleotides into surrounding medium. Impairment of mitochondrial function is also reflected in uncoupling of oxidative phosphorylation, failure of 2, 4 dinitrophenol (DNP) to afford protection against swelling and the significant lowering of the ratio of DNP to magnesium activated adenosine triphosphatase activity. Among the effects of thyrotoxicosis on other subcellular particles to the observed decrease in ribonucleic acid of ribosomes and this may be of importance in view of the recognised ribosomal function in protein synthesis. Other experiments have shown a decreased incorporation of formate-C^{14} into tissue proteins in the hyperthyroid rat.

The lowering of hepatic stores of vitamin B_{12} interferes with the synthesis and utilisation of certain sulfhydryl enzymes. This has been studied both *'in vivo'* and *'in vitro'* with certain model conjugation systems, namely, the peptidation of the constituent amino acids of glutathione and the benzoylation of glycine. The results are indicative of a loss of efficiency in the funnelling of energy obtained from oxidative processes for biosynthetic pathways. Among other major alterations in sulfhydryl metabolism is the observed decrease in glutathione and concomitant increase in the coenzyme A contents of liver. A greater channelling of the sulfhydryl reserves of the cell into coenzyme A rather than into glutathione, possibly as a metabolic adaptation for increased energy production to offset the loss in efficiency of coupling of oxidation to phosphorylation in the thyrotoxic rat is indicated.

The enhancement of oxidative metabolism, as evidenced by increased succinoxidase activity of liver, in thyrotoxicosis, is attended by increases in cytochrome C, cytochrome oxidase and coenzyme Q, important members of the respiratory chain. The increase in coenzyme Q is particularly marked in the mitochnodria. Evidence is available to indicate that the cytochromes increase at the expense of catalase, also a heme-protein, which registers a decline.

Vitamin B_{12} supplementation exerts a significant protection against several of the metabolic derangements caused by thyrotoxicosis. It is possible that this protection might arise from the effect of the vitamin on the glutathione reserves of the cell, since the replenishment of liver stores of the vitamin closely followed by restoration of sulfhydryl reserves of the cell. Since evidence is available of the important role of glutathione in cellular integrity, the correction of several other derangements resulting from morphological damage, by vitamin B_{12}, appears to be indirect through its effect on glutathione. A protection, reflected only in a restoration of the changes in cytochromes and catalase and in mitochondrial swelling has also been observed with magnesium supplementation.

3. D. P. SADHU (Izatnagar) (*in absentia*) : *Vitamin A and Thyroid Interrelationship.*

It is well known that thyroid hormone helps the conversion of carotene into vitamin A and hypothyroid animals fed on carotene sources alone become blind due to nonconversion of carotene into vitamin A. Conversely vitamin A affects the thyroid

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gland. Heavy vitamin A ingestion depresses their basal metabolism and reduces thyroid weight. It also neutralises the increased metabolic effect of thyroxine injection. The decrease in thyroid size is produced by the lowering of the secretion of the TSH by the anterior pituitary. There is an increase in adrenal size also. Studies on reticuloendothelial system show that hypervitaminosis A causes decreased hepatic destruction of thyroxine, resulting in hyperthyroxinaemia; the latter reduces the TSH secretion and consequently the thyroid size.

4. R. CHANDA (Calcutta) (*in absentia*) : *Thyroid and antithyroid Drugs on the Metabolism of Carotene, Vitamin A and Tocopherol in Ruminant and Avian Species.*

Cow and Buffalo. The administration of L-thyroxine orally or parenterallly increased the carotene and vitamin A ester content in the milk and blood serum if Hariana cows. Vitamin A ester content was also increased in the milk and blood serum of Murrah buffaloes treated with L-thyroxine. Vitamin A alcohol could not be detected in the milk of the buffaloes; a small but measurable amount (3 to 5% of the total vitamin A) of vitamin A alcohol occurred in cow milk. The proportion of vitamin A alcohol in cow milk increased significantly during noticeable hyperthyroidism caused by treatment of the cows with thyroxine when the ambient temperature was fairly high.

Buffalo digested dietary carotene better than the cow. The blood and milk vitamin A ester were related to dietary carotene, and the values were greater in the buffalo than in the cow at comparable carotene intakes on body weight basis. The digestibility of carotene increased in both the species during thyroxine treatment, the magnitude of the increase was more marked in the cow than in the buffalo. That the greater digestibility of carotene during thyroxine treatment was due to greater conversion into vitamin A was evident from the observation that measurable carotene could never be detected in the milk and blood of the buffaloes during thyroxine treatment period, whilst noticeable increases occurred in the vitamin A content.

Chicken. L-Thyroxine, aureomycin, vitamin B_{12} and certain other drugs accelerated the intestinal conversion of β-carotene into vitamin A. The blood and liver levels of vitamin A ester and alcohol were also greater in the chickens treated with these drugs. Thiouracil, an antithyroid drug, inhibited the intestinal conversion of dietary carotene. Fractionation of the intestinal mucosa demonstrated that the increase in vitamin A produced by thyroxine treatment or decrease caused by thiouracil treatment occurred in the supernatant fraction of the tissue homogenate in which fraction the bulk of the vitamin A is normally present. In the liver, the increase in vitamin A caused by thyroxine treatment was located in the supernatant fraction and to a lesser extent in the nuclear fraction. The decrease due to thiouracil treatment was mainly in the nuclear fraction. Intestinal absorption of β-carotene as such was not affected in the chickens by the administration of the drugs.

The toçopherol content in the nuclear fraction of heart and liver tissues of chickens were decreased by thyroxine treatment. This was closely correlated with a simultaneous increase in the ubiquinone content of the tissue fractions. The effect was more pronounced when thyroxine treatment was superimposed on vitamin A deficient chickens.

5. S. LAHIRI (Calcutta) (*in absentia*) : *Hormones in ascorbic acid metabolism.*

All endocrine glands are known to contain high concentration of ascorbic acid. This high concentration has been thought to be related with the reported high

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metabolic activity of the endocrine tissues but it has not been demonstrated whether there is a direct correlation between ascorbic acid concentration and oxygen consumption of a tissue. Nevertheless, ascorbic acid has been shown to be associated with the activity of the pituitary, adrenal cortex and islets of Langerhans—some endocrine tissues. Amongst all these pituitary produces the most dramatic effect on ascorbic acid metabolism in the adrenals of certain species. However, the meaning of this association is not known. In a search for the nature of the relationship, the fate of ascorbic acid which disappears from the adrenals on adrenocorticotrophin administration was looked for. Most of the ascorbic acid lost by the rat adrenals appears in the adrenal venous effluent as reduced ascorbic acid. Besides this, it has also come to light that other tissues, liver in particular, release a greater amount of ascorbic acid into the blood under the same condition which raises blood concentration of ascorbic acid significantly. New data will also be presented to show the profound effect of pituitary hormone(s) on another aspect of ascorbic acid metabolism in various tissues of rat.

Teleologically, ascorbic acid seems to go well with hormones : ascorbic acid is dispensable as a vitamin where hormones do not function normally, such as, in primitive metabolic machinery. Ascorbic acid is the only vitamin known to have direct hormonal influence on its metabolism.

6. CHANDICHARAN DEB (Calcutta) : *Effect of Ascorbic Acid Deficiency on the Histochemical Changes in Testes.*

Various histochemical tests were applied on the testes of normal and ascorbic acid deficient guinea pigs with an idea to assess their activity. The more prominent changes observed are as follows.

During ascorbic acid deficiency there was a rise in sudan positive materials in the interstitial cells. These materials responded to histochemical testes for cholesterol. There was also a rise in plasmalogen, which indicated ketosteroids, and an enzyme acid phosphatase in these cells during scurvy. The above changes observed possibly indicated a non-functional accumulation in ascorbic acid deficiency. A reduction in spermatogenesis has been observed under similar condition. There was a marked fall in the number of mature spermatocytes and spermatids. This decreased spermatogenesis caused a fall in the activity of succinic dehydrogenase, both acid and alkaline phosphatases and D.N.A. Changes have also been observed in the tunica albuginia of testes and glycoprotein containing cells of anterior pituitary in the scorbutic guineapigs. Effect of gonadotrophic hormone treatment on the observed changes has also been studied.

7. N. K. ROY (Calcutta) (*in absentia*) : *Influence of vitamin B complex on the maintenance of estrus cycle in mice and rats.*

The role played by vitamin B complex in the intermediary metabolism of carbohydrates, fats and proteins is well known. Their influence on the synthesis and function of various hormones through enzymatic pathways is being worked in recent years. The part played by them in the regulation of estrus cycle seems to be of considerable interest. It has been observed in our laboratory that our inbred laboratory white mice and rats complete one estrus cycle in 5 or 6 days. Peak-estrus showing about 95% of cornified epithelial cells in vaginal smear with almost complete absence of Leucocytes never last for more than 2-3 hours. In mice and rats kept on vitamin B poor diet, it has however been observed after repeated experiments that the estrus state continues for days, obliterating the post-estrus, diestrus and proestrus phases. These animals fail to conceive in almost cent per cent of cases compared with control animals on normal diet. Even in spayed

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animals on vitamin B deficient diet estrogen stimulation by injection produces same change in the vaginal smear which is much more prolonged than spayed controls on normal diet. The same animals on restoration to normal diet or on administration of B complex cease to exhibit such phenomenon and again conceive in usual time. Whether this phenomenon is a direct result of vitamin B deficiency on estrogen or indirectly caused by damages in the liver which is responsible mainly for inactivation of estrogen is under investigation.

8. S. C. JAMDAR and S. MOOKERJEA (Calcutta) (*in absentia*) : *Adrenocortical function in Riboflavin-deficient Rats.*

In riboflavin-deficient rats there was a tendency for liver to assume a greater proportion of body weight. But other organs, such as testis, spleen and thymus did not show any significant change in weights when changes in the weight control groups were also considered. Adrenal weights and their cholesterol and ascorbic acid contents were not affected ascribable to riboflavin deficiency alone.

On 16% casein diet liver catalase activity is greatly reduced but was restored towards normal by feeding 40% cesein diet in riboflavin-deficient rats.

Lymphocytes show a distinctly lower percentage in riboflavin-deficiency among white blood cells.

From these findings a possible effect of riboflavin deficiency upon adrenocortical function will be discussed.

II. GROWTH AND NUTRITION

Jointly with the Sections of Anthropology and Archaeology and Medical & Veterinary Sciences)

Chairman : Dr. G. C. Esh (Calcutta).

Chairman's Introductory Remarks :

Anthropology is concerned with the development of man and his behaviour; nutrition is involved in understanding the specific relationship of man and his behaviour and the environment that nourishes him. The history of man has been one of continuing adjustments to different environments and the diet is one of the most important factors in these adjustments of the organism to an environment. The anthropologists and nutritionists can therefore, benefit from mutual consideration of the behaviour of man. The nutritionists turn to the anthropologists to find better ways to institute changes of food habits in population segments manifesting dietary deficiency diseases. The anthropologists' functional and wholistic approach is of particular utility in trying to find ways to change dietary habits. The nutritionist who clearly identifies certain psychological characteristics with nutritional conditions such as dullness of kwashiorkor in children provides the anthropologist with insights into the culture of the people he is trying to understand. Thus both at the understanding what food man really needs and understanding how to help man get the food he does need there is a broad and productive future for the collaborative efforts of anthropology and nutrition.

Food habits are thoroughly immersed in culture and they affect food intake as importantly as do the soil, the climate and agricultural development. Food-directed behaviour involves much more than the physiological need. It includes appetite, sharpening of brain, aesthetic enjoyments and longevity of life. The crucial problem today is the development and popular acceptance of a diet con-

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ducive to maximal health and vigorous longevity and in this task collaborative efforts from nutritionists, anthropologists and medical men are extremely necessary.

1. P. N. SENGUPTA (Calcutta) : *Nutrients Usages and Growth of the children of different Tribes of India.*

It has been demonstrated that improved nutrition definitely increases the rate of growth of a population group. Due to improved nutrition the boys in U.S.A. were 8% taller and 12% heavier in 1941 than the boys 50 years before. The role of nutrition in 'Chemical Growth' has been extensively studied from infancy to adolescent stage and such studies included intellectual and psychological aspects, character, alertness and physical fitness. The growth and development signify, in broader sense, the increase in stature and weight corresponding to ages from 5 years to 14 or 15 years age. It is also known that nutritional qualities of the dietaries have profound effects on the growths in weight and stature.

In the nutritional investigations undertaken among many tribes living in different parts of India, the diets of random selected families in each village were surveyed, their nutritive values determined and the average intake of calories, protein and ten nutrients were assessed. For the present discussion, intake of calories and protein have only been considered to determine their effects on their growths. The children of each tribe, of 5 to 15 years age groups, were measured for stature and weight and vital capacity etc. The overall increases in stature and weight from 5 to 14 years age have been taken as their growths. 15 tribes had been studied, of which 4 were of NEFA, 3 of Tripura, 2 of Bihar, 2 of M.P. and 4 were of Kerala.

Maximum growth in weight were recorded in the children of Galong tribe of Abor hills, NEFA, and of Riangs of Tripura who had comparatively most satisfactory diets and lowest percentages of families deficient in the intake of calories and protein. Minimum growths had been found in the Nocte tribe of NEFA and in the Travancore tribes who had lowest intake of calories and protein and as high as 87 to 93 per cent families were deficient in the intake of calories and protein. Further results showed that two groups of the same 'Minyong' tribe of Abor Hills living in two settlements, Balek and Ledum, 20 miles apart, had different rates of growth in weight due to the fact that Balek group had better nutrients usages due to improved cultivation than Ledum although both the groups were of same racial heredity and had marriage relationship. Furthermore, the same families of Santals of Santal Parganas and Ho tribe of Singhbhum, Bihar, were surveyed in 1940 and again in 1952, 12 years later. Both the tribes in 1952 had increased intake of calories and protein by about 800-900 calories and about 20 gms. respectively. In both of these tribes the stature and weight of the boys had increased by about 1·5 inches and 2·5 to 3 pounds respectively. These investigations proved beyond doubt that even the tribals, who did not generally buy foods from the markets, had growths according to the nutrient contents of their dietaries and also the tribal groups of the same racial heredity had growths of their children differently according to the differences in their intake of nutrients.

2. KALYAN BAGCHI (Calcutta) (*in absentia*) : *Nutrition and the growth of the eye-ball.*

Proper growth of the eye-ball, with its different component parts is essential for correct vision. It is believed that being a vital organ, its growth as a whole is to a large extent independent of nutrition supply. The growth of the different component parts of the eye-ball, in relation to each other, is of much greater

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importance in the functional aspects of the eyes. Recent investigations with human eyes suggest that the growth of the cornea, lens and the retina and the refractive indices of mainly the cornea and the lens control the refractive power of the eyes. Chemical composition of the cornea and the lens might also influence their refractive indices. Thus, nutrition, by affecting the growth of the component parts and in the refractive indices of some of them might play an important part in controlling the refractive power of the eyes.

Refractive power aberrations especially in the form of myopia has been described recently as correlated with protein deficiency. Myopic process has been halted with animal protein supplementation of the diet. The incidence of myopia was found to be extremely high in student population, in whom the general standard of health and nutrition was found to be extremely poor.

Experiments were conducted on albino rats of Glaxo strain and rabbits on a protein deficient diet and the different components of the eye-ball were examined. The following findings were found to be of importance :

(A) histological and histochemical examination of the cornea revealed that the stroma of the cornea is distorted in architecture followed by hydration—an important factor in disturbing the normal refractice index of the cornea.

(B) altered structure of the cornea will disturb the power of the cornea to adapt its curvature to suit the growing eye-ball.

(C) protein malnutrition produces changes in the sulphydryl distribution in the lens, its amount in the cortex in the lens is significantly reduced and the lens nucleus accumulating a large amount of disulphide groups. Actual measurement of the refractive index of the lens by Abbe's refractometer using bovine albumin showed a rise.

(D) gross alteration in the histological structure of the retina suggesting its inability to act as a co-ordinator of the different components of the eye-ball.

The above evidences indicate that in case such changes occur in the human eye as a result of protein malnutrition, refractive error in the form of myopia will set in.

3. KAMALA SOHONIE, K. V. PANSE and S. H. MAHISHI (Bombay) (*in absentia*) : *Effect of Neera on the Growth of School Children.*

Neera is a good source of minerals and vitamins. Work regarding nutritive value of Neera on animals was done before. It is therefore, thought of interest to study the effect of Neera on the growth of school children. One hundred and eight children residing in three different hostels were selected for the experiment. They were divided into two homogeneous groups. Experimental group was given one glass of Neera while control group was given one glass of sugar solution. Weight, height and haemoglobin were recorded before and after the experiment. The difference in weight between the experiment and control varied from 0·2 to 1·4 lbs. The difference was statistically significant in the case of one hostel. The difference in height ranged from 0·4 to 1·3 inches and it was statistically not significant. As regards haemoglobin the difference was from 6·2 to 9·12% and it was statistically significant in the case of two hostels.

4. B. S. KAUSHAL, D. N. MULLICK and N. D. KEHAR (Izatnagar) (*in absentia*) : *Effect of different zonal feeds on the rate of growth of Bengal and Hariana calves.*

16 calves of 9 to 11 months old of dry hot zone (Hariana breed) and humid hot zone (Bengal breed) were divided into 2 groups. One group of both the breeds was fed with Punjab diet and another group with Bengal diet. All the feeds of

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Punjab diet were brought from Hissar, Punjab at regular intervals and for Bengal diet they were procured locally. The diets were made balanced and isocaloric. They were adequately fortified with trace mineral mixture and synthetic vitamin A. Body weights were recorded weekly for 100 weeks. Antihelminthic drug was administered at regular interval. The experimental station was at Calcutta.

The average four weekly rate of growth are as follows :

Hariana heifers on Punjab diet	...	...	... 17·98 lbs.
Hariana heifers on Bengal diet	...	...	... 17·81 ,,
Bengal heifers on Punjab diet	...	...	... 11·32 ,,
Bengal heifers on Bengal diet	...	...	... 10·58 ,,

Critical examinations of the results indicated that the groups on Punjab diet in each breed had higher rates, but statistical calculations of the data according to analysis of variance showed that 'F' ratios between the dietary groups within each breed turned out to be insignificant.

From the present observation, it may be concluded that if the feeding conditions are adequate and diseases especially of parasitic origin are controlled, the humid tropical conditions do not adversely influence either the growth rate pattern of imported calves from dry tropical zone or local stock.

5. SUJATA CHAUDHURI (Calcutta) : *Statistical analysis of data of height, weight and Haematological Values of new born babies in Punjab and in Bengal.*

It is generally believed that normal new born babies of Punjab are healthier than that of Bengal. A statistical analysis of data of height, weight and of Haematological values—Haemoglobin and Red blood cell count, on new born babies in Punjab and Bengal is done.

It is found that mean height and weight of Punjab babies are not significantly greater than those of Bengal babies, the same applies also to the Haematological values, from t-test results.

No significant difference detected from this sample between males and females with respect to each of the above characteristics both in Punjab and Bengal as per table III. There is no significant difference between Punjab and Bengal as regards these characters as per table IV.

III. STRUCTURE AND FUNCTION OF SYNAPSES

Chairman : Dr. G. C. Esh (Calcutta)

Prof. STEPHEN, W. KUFFLER (Harvard University)—Spoke about the general physiology behind the structure and function of neuro-neuronal and myoneural junction. He elucidated the biochemical and bio-electrical phenomenon e.g. the role of chemical mediators, acetylcholine, adrenaline or noradrenaline and the importance of synaptic and end plate potential in the mechanism of transmission of nerve impulses along these regions.

Prof. E. DeROBERTIS (Argentina)—Ultramicroscopic structure of the synaptic regions were demonstrated by Prof. DeRobertis with the help of some fine slides. His electro microscopic observations revealed that probably there is some sort of structural continuity between an axo-deudronic or synaptic junction. His electron microscopic studies, specially in relation to suprarenal gland, pineal body, hypothalmus and hypophysis emphasized the importance of neuro-endocrine hypothesis.

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PROF. W. D. M. PATON (Oxford University)—Spoke on the mechanism of action of drugs acting on the synaptic region. He explained the mode of such therapeutic agents on the basis of receptor theory. He also placed that the mechanism of competitive or non-competitive action of these drugs on the receptors of the effector organ may be compared with the mechanism of enzyme action. His approach to the mechanism of action of such pharmacological agents on the basis of enzyme kinetics applying the Michaelis Menten equation is of much interest.

The Chairman summarised the salient features of the papers presented and invited discussion from the members present. Dr. Ghosh, Dr. Krishnamurti, Dr. Kar, Dr. Sen and others participated in the discussion.

I. NATURE OF PERSONALITY

Section of Psychology & Educational Sciences

Chairman : DR. G. D. BOAZ, Madras.

Dr. E. I. George opened the discussion. Among other thing he emphasised on the application of factor analysis.

1. E. I. GEORGE (Kerala) : *The Nature of Personality—A Dimentional Approach.*

The necessity for a scientific study of personality is indicated. In personality we study the individual in totto. Existing theories have been classified into two viz. dynamic and static. The view that static theories should precede dynamic ones is stated. It is held that attempts for taxonomy is a desideratum in the field of personality. The Eysenckian theory of personality is discussed and an appeal is made to adopt factor analysis as the method for categorization in personality.

The essential application of factor analysis in the new branch of research in psychology namely Psychopharmacology is advocated. Finally the successful employment of the dimensional approach to study intellectual abilities and problem solving behaviour. Cognitive abnormality, Heredity and Psychological abnormality, constitutional factors and abnormal behaviour are mentioned.

2. M. S. PRASAD :

The present concept of personality in the light of modern psychology does not explain all the human peculiarities but yoga psychology seeks to explain them. So this yoga psychology should be studied according to modern research techniques. Fortunately such attempt has been made by the Research Centre of Creative Altruism of Harvard University. The yogic concept of human personality should make a contact with the above said University and take some steps which will be helpful in India.

3. DR. D. GANGULI :

In my opinion the attempt of Dr. E. I. George was to emphasize on the methods of assessing personality aspects under different dimensions whereas Mr. I. B. Sachdev was that of yogic methods on the influence it makes, in changing personality by knowing his present self and having an idea of desired personality pattern. So, I think that two papers deal with two different aspects of knowing and understanding personality.

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II. PROBLEM OF STUDENT UNREST

Chairman : Dr. G. D. Boaz, Madras.

1. Dr. SRI CHANDRA (Lucknow) :

Student unrest is universal but the form it takes in Indian Universities is diversified and a matter of degree. The ill behaviour of student is only a project of the same in the teacher or other elders and companions in the society.

Students' unrest is due to many factors but in certain cases students come to the University to enjoy life—not to study.

Human and Psychological approach to the problem would be more rewarding.

2. B. C. KAR (Cuttack) :

Students are over indulged by the authorities. Political parties control students' unions and hence indiscipline. Students should be engaged in active pursuits besides studies. Teaching aptitude in teachers is important.

3. R. C. DAS (Cuttack) :

Student's personal work would reduce student unrest. This would remove frustrations from students which they may carry from home.

4. PRIYARANJAN MOHAPATRA (Cuttack) :

Adjustment of students to the fast changing conditions should be brought about. Aspiration and achievement should not have a big gap.

5. Dr. S. Sinha (Calcutta), read a paper in which he stressed the need for a thorough probe into the matter both from the University as well as from various other sources.

Sri Asit Nath Deb (Delhi) and Dr. K. N. Sharma (Calcutta) laid emphasis on certain aspects of examination system.

Dr. R. G. Chatterjee (Calcutta) said that an opinion survey showed that unrest may be attributed to : (a) favourable family condition, (b) effect of various movements organised by different political parties, (c) insufficient preparation for the examination etc. The speaker laid more emphasis on further study and report.

The yogic system more or less takes the position vis-a-vis those taken by neuropsychology or that of psycho-pharmacology.

SCIENCE, FREEDOM AND HUMAN PROGRESS

Section of Science and Its Social Relations

Chairman : Dr. B. Mukerjee, Lucknow.

1. U. P. BASU (Calcutta) : *Science, Freedom and Progress : Need of Co-ordination and Planning.*

Science is the process that men of all nations have evolved in their search for truth. In doing so the followers of this discipline have worked out methods by which people can live in peace and contentment. With urbanisation the concept of values of life has, however, undergone a change and the voluntary co-operative communism in which the majority of the people in a country worked together for the good of their community has disappeared.

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In any progress for meeting the needs, requirements, health and pleasure, scientists and technologists are now playing a greater role. In such an endeavour their movements, will, or freedom should not be shackled, as otherwise the best cannot come out of their efforts. How one will look upon another is, of course, a matter of every man's own conscience, but the best intellect, initiative, and drive would come from a man when he is free to work for himself and for his comrades in the society in which he lives.

The utility of science for the benefit of mankind is revealed through the work of the scientists, but their creative ability will be fully manifested if there be opportunity for work in an organised and co-operative way whether in the field of education, research, industry or administration. Success in scientific achievements needs co-ordination and planning. The well-known physicist engineer of the U.S.S.R., Prof. P. L. Kapitza, recently remarked that the success of science in the Soviet Union, is due mainly to the mobilization of the means and the scientists, and to the concentration of their ideas on an important task. It is to be remembered that creativeness of the individual is at the root of any human progress, but the individual should not deviate from the vision that the ultimate success in creation of his own society and nation lies in group action.

Science is the modern instrument that is helpful in enhancing the prestige and prosperity of a nation. The scientists must, however, see that it is not abused, or, exploited for industrial, military or political purposes in the greater interest of mankind as a whole.

2. PRIYADARANJAN RAY (Calcutta) : *Science, Freedom and Human Progress.*

Science, with truth as its objective and with its dislike for untested faith, has eliminated many social evils and heralded a new era of reason and free thinking. But offering a mechanical explanation of nature it has at the same time given rise to a materialistic philosophy of life. Matter and motion are regarded as the only really real elements of reality. It denies freedom to human will and action, giving prominence to the law of causality as a universal principle. Moral values are discarded except for utilitarian purposes. Pleasures and enjoyments are viewed as the sole purpose of life, leading to an unbridled lust for power and possession with its attendant evils of widespread strife and suffering. The physical and psychological enslavement of man and a cold war with its dire threat of his annihilation by a nuclear warfare have been the outcome. The spectacular and almost miraculous triumphs of technology have merely provided a tower of strength to this materialistic philosophy of life.

The enormous and unlimited power, furnished by science and technology, is wielded only by a few in the society—the capitalist or the ruling minority. They are armed not only with the power of coercion (military and police), but also with that of persuasion (newspaper, radio and cinema). The masses are thus deprived of all their freedom, and submit to the dictates of their rulers for the sake of their subsistence and security.

The progress of technology through its labour-saving devices has led to unemployment with consequent social and economic insecurity. The growth of industrial cities and towns with congested quarters and artificial ways of life for the workers offering no creative interest in their work, serves nearly to complete the process of physical, psychological and moral enslavement of the people.

The spirit of nationalism has been instrumental in further intensifying the process of mass enslavement and in giving rise to power-blocks and armament race on a colossal scale. The enormous amount of money and resources are thus being wasted for the production of, and researches on, war materials and war

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weapons. Scientific materialism coupled with nationalistic sentiments has thus given rise to a new type of irrationality and illusion.

The primary need of humanity and the real problem of the world today is the production of sufficient food for all. The first and the foremost concern for the common man is his next meal. The masses have little interest in national or international power policies. But the ruling powers will not leave them in peace and in the name of safeguarding their welfare and interest do not hesitate in adopting policies and measures spelling ruin and disaster for them.

The need for a new outlook in science can, therefore, be hardly emphasized.

3. K. RAY CHOWDHURY (Aligarh) : *Science, Freedom and Human Progress.*

The topic is extremely complicated, and unless a speaker starts with a base, his talk would be meaningless and invite criticism from all corners. It is desirable that we should first define the terms, Science, Freedom and Human Progress. We would agree on the point that Science is systematic knowledge derived from empirical methods. Also, it is hoped, we would agree to the extent that the horizon of our ignorance is gradually vanishing because of our continual process of discovering facts and enriching the storehouse of science. Science in return opens our eyes and gives freedom to move in a direction that we had never thought of in the past. Therefore, the base of freedom is creation or discovery and *not* time and space which can be shown, from the philosophical angle, as always varying and not remaining constant.

Now the question arises as to which particular branch of science, the present speaker would like to pick up as his base of the above statements. Of course, it is psychology. And since the present occasion gives a speaker the liberty to show off a little, the present speaker would submit some new discoveries done by him and his two disciples, namely, Dr. Raj K. Ojha and Dr. Aquil Ahmad who recently received Doctorate Degrees working on two topics under the supervision of the present speaker.

The present speaker and Dr. Raj K. Ojha in 1957, 1960 worked on "Intelligence and Intellectual Stimulation during Adolescence" and verified the claims of Professor P. E. Vernon (1957) that intelligence could not be described as "hereditary" since we have no instrument to measure it. Therefore, whatever planning we may have in connection with the educational systems to nurture the young adolescents, we must not forget the freedom we have out of the knowledge derived from empirical studies on the issue. We can therefore train our children and develop their ability factors according to our bigger national plan if we have any.

Dr. Aquil Ahmad and the present speaker in 1957-1960 worked on "Factors in Attitude Formation towards Democracy" and empirically verified the claims of the present speaker (also cf. Ray-Chowdhury, K., *Modern Review*, October, 1952) that "Gandhian Personality" would help us study both the problems of personality and those of attitude in psychology in a much better way than Adorno's (1950) Authoritarian Personality Approach in the field since the new concepts of non-violence and violence described by Gandhi (Cf. Bose, N. K., 1947, *Studies in Gandhism;* Dhawan, G., 1951, *Political Philosophy of Mahatma Gandhi*) are neither found in the Psychological literature manufactured in the West nor are they actually understood by the Western psychologists because of the lack of skill on the part of those who understand the terms, to discuss the issue through the western methodology. The present speaker therefore constructed a scale, jointly with his above disciple with the scaling principle as laid down by Allport and Vernon (1951) in their Study of Values, on "Attitude of Non-violent Non-cooperation Towards (Gandhian) Democracy" using the concept of "just selfishness"

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as the base of Gandhi's Democracy and choosing items according to Gandhi's concept of "violence and non-violence of the coward" under "violent co-operation and violent non-co-operation" categories on the one hand, and that of his "violence and non-violence of the brave" under "non-violent co-operation and non-violent non-co-operation" categories on the other. In the process of the above research it was possible to measure the degree of identifiability of "non-violent non-co-operation" and "non-violent co-operation" with Adorno's (1950) "authoritarian agression" and "authoritarian submission" respectively. The above research, the present speaker believes, opens the eyes of Western psychologists and Indian thinkers to the extent that there was so far a lack of our understanding on a vital point regarding the nature of Gandhian non-violent non-co-operation which could be used both as a trait in personality measurement and as a wonderful strategy in warfare. If we are satisfied on the issue, the speaker thinks we shall have freedom to solve our differences and press more scientifically the issue on disarmament. So, how could we say that science does not give us freedom to have human progress ?

4. NILAKANTHA ACHARYA (Cuttack) : *The limitations of science for human welfare.*

"Science is a progression of tested propositions leading to general laws and applied to scientific problems or as a continuing adventure of the human mind in which the challenge of the unknown is matched by the creative spirit of the man, a constructive stirring of minds to find order, unity and intelligibility in natural phenomena and events which to the untutored mind appear haphazard or capricious."

The ardent zeal and devotion in scientific men for the quest of the truth of science is itself a sufficient testimony that it must meet one of the deepest needs of human nature namely the desire for beauty. It is in this aesthetic aspect that the chief charm of science resides. To the majority of laymen, science is valuable chiefly for its practical application. But to all the greatest men of science practical applications have emerged incidentally as a sort of by-product. To the great man of science, science is an art and he himself is an artist. His work is not the less a work of art because it is but a faint and imperfect copy of another—of the supreme work of art which is nature itself.

The 20th century has witnessed a remarkable progress in the field of scientific discoveries. Although many epoch-making discoveries have been made in the past, their application for practical purposes and rapid development of the associated sciences has become a phenomenon of the 20th century. So science has served humanity and made the way for its progress most in the present age, rather than in the past. Perhaps in no fields of science could the constructive use of scientific discoveries be more clearly demonstrated than in the field of medical sciences. For example, many important drugs have been found out that are capable of destroying some of the most harmful bacteria which took a heavy toll of life before. The relations of science to society have been full of promise. In this age scientific achievements have been outstanding and full of promise for the greater possibilities of human welfare than ever before. Let us hope that there will be future Newtons, Faradays and Ramanujams to provide new insight into the eternal mystery of the universe.

The social need of the present day requires scientific planning so that individual scientists may be guided to the more urgent needs of society. It saves the time lag with the saving of millions of human lives or increasing the welfare of mankind at large. In fact a better system of scientific education should be

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adopted to a society consciously aimed at securing the maximum human welfare. Science knows no frontiers. This has been well manifested by many international scientific organizations. For example, the International Geophysical Year is a period of an organization undertaken in collaboration with as many as about seventy nations of the world. But also many disciplines of scienre have their part to play in making observations during this period, leading to the discovery of the secrets and mysteries of the planet on which we dwell. Therefore the approach seems to be a happy movement towards the universality of science from all points of view.

But unfortunately the danger is of giving science too much credit. Now that the problem is rather that of finding the means by which science can be directed to constructive and not to destructive ends so that it can serve for human progress rather than for the total annihilation. Knowledge as such can never provide a moral mode of living, nor insure salvation for mankind. Today science has failed to control tyranny and brutality. It is primarily because the modern age has overestimated the power of secular and material knowledge to influence the conduct of human beings. We have interpreted science wrongly by expecting it to serve a purpose which is not in its domain—the creation of an ideal society.

"The complete divorcement between scientific research and spiritual and moral ideas has brought disastrous consequences. A science which remains indifferent to the importance of morality in the life of society becomes an opponent of morality. The end of learning should be the cultivation of intellectual and spiritual values bringing to a maximum development the moral potentialities of man."

However it must be admitted that science is for its own sake. That is some work on science with passionate zeal to explore and study for study's sake only without any motive or implication of its application for human welfare. So much cannot be expected from science for the benefit of the mankind at every stage.

Also some fundamental changes in the social structure in mankind is necessary to bring about any radical progress in science.

5. NIRMAL KUMAR BOSE (Calcutta) : *Science, Freedom and Human Progress. The Progress of Science*

Science has raised the power of mankind to almost unprecedented levels. Atomic power has not yet become an economic proposition; but there is no reason why it should not be one in the near future. The sun's rays may one day yield up their resistance, and be converted into cheap electricity for human use.

Metals which were once rare, are now more easily available. New alloys have been produced to serve many new purposes. It appears that plastics will take the place of several raw materials which are now considered indispensable.

Microscopes and calculating machines have been improved to an extent undreamt of in the past. These have lightened the scientist's work, and made work faster and more accurate.

Comparable advances have taken place in chemistry; so that the distinction between the living and non-living has been progressively reduced. We are perhaps on the threshold of an era when life-processes will yield up their secrets, and a control over them will be exercised by man in a manner which is comparable to that exercised over inert matter.

Conspicuous advances have also been made in the field of psychology. Freud's investigations have opened up a new way of understanding the human mind. Numerous observations are being made in many laboratories of the world on individual and collective behaviour. And, although the progress made so far has been

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small in comparison with achievements in the physical sciences, or even in biology, yet it has not been altogether negligible. At least, researches in human behaviour and methods of communication have armed leaders of various communities with powerful weapons by means of which they can mould men's opinions or actions towards particular ends.

Progress has undoubtedly taken place in numerous directions. Man has gained a sufficiently deep understanding of nature's processes to enable him to secure a fuller satisfaction of his bodily needs.

The Social State

But power thus gained through the services of science is not evenly distributed. Both scientific knowledge and its application in the world are in short supply. Or perhaps the economic and administrative machinery by means of which these benefits can be utilized for the enrichment of human life as a whole, has till now proved to be inadequate for the purpose. Particular nations, or small groups of privileged persons within a nation tend to keep within their dispensation the benefits which accrue from science.

Power derived from scientific advance does not also necessarily come to a nation or community which is endowed with moral worth, and become denied to another of the opposite kind. It seems to accumulate without reference to the social ideals to which a nation may chance to subscribe.

As a result of all this, there is a scramble for power; and the character of war has also become completely transformed. No boundary is today able to secure immunity to a nation from destruction. In addition, that destruction involves, not combat forces alone, but the whole population of a country which is situated in strategically significant neighbourhoods.

War has also become so expensive and complicated in organization that small nations cannot hope to prepare adequate defence by means of their unaided strength. They have to tow the line with one or another power block.

A hope has occasionally been expressed that the fear of atomic destruction will restrain the hands of those who wish to involve mankind in war. This is perhaps an idle hope. Perhaps hundred-megaton bombs will not be used in actual combat, but will only be blasted for yielding rich political harvests. Wars of attrition will still be carried on, while nations will continue to arm themselves with atomic weapons in order to maintain a rather precarious balance of power in their own favour. Today every block tries to remain at the top; but as two cannot occupy the same superior position at the same moment of time, this race for destructive weapons and defensive apparatuses will continue to consume a larger proportion of man's total output of energy than ever in the past.

Moreover, this continuous war of attrition in which the modern world seems to have become involved, has tended to maintain men in a state of anxiety, and constant psychological preparedness for an armed conflict.

Some social philosophers have expressed the view that the present sufferings of mankind in the midst of a promise of plenty is on account of the fact that development in the art of social integration have not been able to keep pace with development in the technological sphere.

Freedom attained so far

Science has furnished mankind with a promise of freedom from want and fear of disease and early death. This has indeed been a superb achievement.

But the freedom to pursue one's aims in the arts or sciences, or in social living are not today available to all members of the human family in an equal measure. Indeed, it lies within the reach of only a small fraction. Hence the envy and

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hatred, on the one hand, and the anxiety and fear which seem to have infected men's minds on the other is likely to undo many of the gains which have otherwise been registered.

The nature of the freedom achieved has been, in addition, of a limited character. Thus there is security from the threat of want and the ravages of disease. In certain fields, again, a release has been achieved from the fear of scoial restraint or of compulsion. Such freedoms, being of a negative character, do not *by themselves* create the best conditions of human growth. A more positive content of freedom is needed before the best in human nature can spring forth under its magic influence.

Another Meaning of Freedom

A garden proves best when individual plants and their flowers turn out to be best. Similarly, a social organisation has to prove its worth by the excellence attainable by individuals living within its compass. If such excellence is open to a small proportion, then the organisation is considered to be inferior to another in which the same opportunity is offered to many without restriction.

When the weeds which choke the growth of a plant are destroyed, and the plant left free to grow as best it can on its own account, that alone may not constitute the optimum condition for the promotion of excellence. Perhaps the growth of a plant may also be hampered by internal as much as by external conditions. After attending to external conditions, and getting rid of them, the need may arise of attending to the remaining conditions so that excellence may be positively promoted from within. Perhaps the distinctness drawn here between external and internal is less than we imagine; yet in the present state of our knowledge the difference cannot be wholly ignored.

Some of the great teachers of mankind have said that the attainment of freedom, and of excellence, depends more on internal than on external circumstances. The latter are necessary, but the critical conditions lie within. In the words of such teachers, freedom means a liberation from inner bondages, from likes and dislikes, so that the truth of a specific situation, or even of a larger kind, like the relations between man and man and between man and nature, may shine clear before him with the utmost clarity. This inward freedom has been cherished by many a great teacher; and those who have left any record of experiences have borne testimony to the fact that the mind is then not only raised by the realization of truth, whether particular or abstract, but the whole being is then steeped in a kind of joy which is not attainable by any other means.

An inward joy of the same nature has also been experienced by some of the greatest men of science. And there is no reason why its attainment may not be converted into a possible experience for larger numbers of mankind. Indeed, the methods of science have already brought to the doors of many, the possibility of attainment of objective truth. Formerly, that lay within the reach of only a privileged few. Science has democratized the serach for truth. Why should it not be able to democratize the attainment of an inner joy which springs from freedom achieved?

When sciences like psychology or anthropology are pursued in the proper spirit, they help us to see ourselves as in a mirror. Then, petty attachments to particular values can be viewed in a new perspective, and one's mind becomes progressively freed from what has been symbolically denoted as 'bondage' in the religious literature of the world.

Without in any way trying to belittle the importance of science's achievements, in fact even while welcoming all that has been done to relieve mankind of fears of a hundred kinds, may we not hope that its services will now be turned in the

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direction of the attainment of a new freedom : freedom from the bondage of fear of our fellowmen, of the communities which they have built up for the incorporation of new systems of values, and which each tries to preserve by raising round it high walls of self-interest ?

Perhaps it will be in this field that further conquests of science will be scored in the future.

In the past, there have always been a handful of individuals who have attained the highest measure of inward freedom. Perhaps, in our age, science will be able to show the way to its large-scale attainment. As the human family grows in number, and as inter-human relations become woven into a more complex network, the benefits of freedom in both the physical as well as mental spheres should be shared in common, or at least made available in an equality of opportunity to all without discrimination.

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APPENDIX

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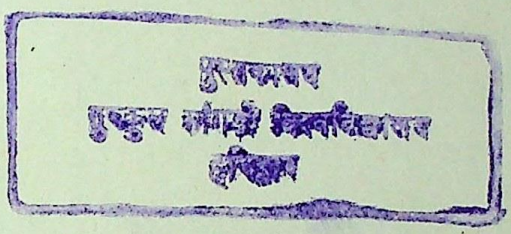
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